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Financial consequences for Danish fishermen following reductions in the Baltic Sea cod and herring quotas

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Introduction

The end of August 2019[1], the European Commission put forward a proposal for the fishing opportunities in 2020 of cod (*Gadus morhua*) in subdivisions 22–24 (western Baltic Sea), cod in subdivisions 25-32 (eastern Baltic Sea) and herring (*Clupea harengus*) in subdivisions 22-24 (western Baltic Sea). See Annex 1 for the location of subdivisions.

For cod in subdivisions 22-24, the proposal sets the Total Allowable Catches (TAC) to 3,065 tonnes, which will result in a Danish cod quota of 1,337 tonnes in 2020. Furthermore, the proposal forbids catches of cod in subdivision 24, thus implying that the quota can only be caught in subdivision 22 or subdivision 23. For cod in subdivisions 25-32, a TAC of zero ('no TAC') is proposed in 2020, thus resulting in a zero Danish cod quota. Finally, the TAC for herring in subdivisions 22-24 is proposed set to 2,651 tonnes, resulting in a Danish quota of 372 tonnes in 2020.

The development in the three quotas allocated to Denmark can be seen in Table 1. For the years 2016-2019, the quotas includes any quota exchanges undertaken during the respective years, see Annex 2 for the quota exchanges undertaken during each year.

Table 1 Danish quotas including quota exchanges 2016-2020 (1,000 tonnes)

Quota species	Subdivisions	2016	2017	2018	2019	2020*
Cod	22-24	6,751	3,211	2,592	4,474	1,337
	25-32	9,940	8,081	7,348	5,565	0
Herring	22-24	6,227	7,041	4,550	1,819	372

Source: The Danish Fisheries Agency.

Note: * Proposed Danish quotas for 2020.

Based on the proposed TACs, the Danish Ministry of Environment and Food has requested an analysis of the financial consequences for Danish fishermen of these proposed quotas for 2020, the possibilities for the fishermen to adapt their fishery to this situation, the possible implications for the onshore services and processing industry and the impact on the employment in the fishing sector.

The Department of Food and Resource Economics, University of Copenhagen has addressed these questions through the research-based consultancy contract that the Department has with the Ministry of Environment and Food.

The requested analysis will be undertaken in this note using the same data sources and approach as used in Andersen, Frost and Andersen (2016)[2].

[1] European Commission (COM_2019_380_1), Proposal for a Council Regulation fixing for 2020 the fishing opportunities for certain fish stocks and groups of fish stocks applicable in the Baltic Sea and amending Regulation (EU) 2019/124, as regards certain fishing opportunities in other waters.

[2] Andersen, J. L., Frost, H. S., & Andersen, P., (2016). Financial consequences for Danish fishermen following a reduction in the cod quota for the western Baltic Sea, 15 p., (IFRO Commissioned Work; No. 2016/16).

1. Description of the Danish fishery for cod and herring in Baltic Sea

Based on data from the Danish Fisheries Agency, the Danish fishery for cod and herring in the Baltic Sea is described below based on the latest available year, 2018.

By the end of 2018, the Danish fishing fleet consisted of 2,157 vessels. Overall, 322 vessels registered in the fleet register by the end of 2018 landed cod and/or herring caught in either subdivisions 22-24 and/or subdivisions 25-32. Of these 322 vessels, 32 vessels landed herring caught in subdivisions 22-24, 298 vessels landed cod caught in subdivisions 22-24, while 43 vessels landed cod caught in subdivisions 25-32.

The distribution of the 322 vessels on length, gear and commercial groups is shown in Table 2. There were 124 commercial vessels having a total yearly landings value above 270,000 DKK (36,000 €) from their entire fishery, while the remaining 198 vessels were less active-commercial having a landings value below 270,000 DKK, but above 0. These less active-commercial fishermen are primarily part time fishermen, who have registered landing values so low that they most likely also have another income in order to sustain a reasonable living standard.

Table 2 Number of vessels landing cod and/or herring from the Baltic Sea, 2018

Length	Primary gear*	Commercial vessels**	Less active-commercial vessels	Total
<12m	Gillnet/hook	32	112	144
	Dory/trap	6	53	59
	Seine/gillnet/trawl	24	33	57
	Trawl	6		6
	Total	**68**	**198**	**266**
12-15m	Seine/gillnet/trawl	7		7
	Trawl	10		10
	Total	**17**		**17**
15-18m	Seine/gillnet/trawl	7		7
	Trawl	22		22
	Total	**29**		**29**
18-40m	Trawl	10		10
	Total	**10**		**10**
Total		**124**	**198**	**322**

Source: The Danish Fisheries Agency Vessel Register and Sales Notes Register 9th August 2019.
Note: * For discretionary reasons, all fleets with less than 5 vessels have been included in other fleet with the most similar characteristics. The following changes have been made for the commercial vessels: 1) Gillnet/hook and seine 12-15m has been included in seine/gillnet/trawl 12-15m, 2) Gillnet/hook 11-18m has been included in seine/gillnet/trawl 15-18m, 3) seine and trawl 18-24m and trawl 24-40m have been included in trawl 18-40m, and 4) mussel fishery has been included in seine/gillnet/trawl less than 12m. For the less-active commercial vessels, trawl less than 12m, seine/gillnet/trawl, seine and trawl 12-15m have all been included in seine/gillnet/trawl less than 12m.
Note: ** A commercial vessel has an yearly landings value above 270,000 DKK, while a less active-commercial vessel has an yearly landings value below 270,000 DKK.

How the economic dependency on the fishery in the Baltic Sea was in 2018 for the 322 vessels registered in the fleet register by the end of 2018 is shown in Table 3. The table shows the overall dependency of fishing in the Baltic Sea, and not only the dependency on cod and herring. The reason is that the fishery, especially for cod, can give rise to bycatches of a range of other species, thus a reduction in these quotas can imply a reduction in the landings of these other species as well. Herring is caught in directly targeted fisheries.

Out of the 322 vessels, 253 vessels had a 90-100% economic dependency (measured by landings value) on fishery in the Baltic Sea. For the commercial vessels, 65 of these had a dependency between 90-100%, thus comprising approximately 50% of the 124 commercial vessels active in the Baltic Sea. The remaining commercial vessels had a lower dependency, and 32 had a dependency below 30%. For the less active-commercial vessels, 188 vessels out of 198 vessels had a dependency above 90%.

Table 3 Vessel economic dependency on fishery in the Baltic Sea, 2018

	Commercial vessel					Less active - commercial vessels		Total
Interval	<12m	12-15m	15-18m	18-40m	Total	<12m	Total	
90-100%	52	10	3		65	188	188	253
80-89%	1		1		2	2	2	4
70-79%			2		2			2
60-69%	4		1		5	1	1	6
50-59%		1	4		5	2	2	7
40-49%	2	1	2	1	6	1	1	7
30-39%	3		4		7	3	3	10
20-29%	3	1	6	1	11			11
10-19%	2	1	3		6			6
0-9%	1	3	3	8	15	1	1	16
Total	**68**	**17**	**29**	**10**	**124**	**198**	**198**	**322**

Source: The Danish Fisheries Agency Vessel Register and Sales Notes Register 9th August 2019.
Note: See note to Table 2 regarding adjustments for discretionary reasons.

Table 4 and Table 5 show the total landings weight and value of cod in the Baltic Sea divided between subdivisions 22-23, 24 and 25-32. In total, 5,193 tonnes of Baltic Sea cod was landed in 2018 at a value of 55.3 million DKK. It is the commercial vessels, which lands the majority of the cod caught.

Table 4 Total landings weight of cod in the Baltic Sea per fleet (tonnes)

		Commercial			Less active-commercial			Total cod
Length	Primary gear	Sub 22-23	Sub 24	Sub 25-32	Sub 22-23	Sub 24	Sub 25-32	Baltic Sea
<12m	Gillnet/hook	522	102	4	118	70	35	850
	Dory/trap	16	13		35	4	1	68
	Seine/gillnet/trawl	175	51	325	33	29	13	626
	Trawl	89	47	76				213
12-15m	Seine/gillnet/trawl	74	1					75
	Trawl	26	175	150				351
15-18m	Seine/gillnet/trawl	123	222	600				944
	Trawl	188	404	946				1,538
18-40m	Trawl	21	76	431				527
Total		**1,233**	**1,090**	**2,532**	**186**	**103**	**49**	**5,193**

Source: The Danish Fisheries Agency Vessel Register and Sales Notes Register 9th August 2019.
Note: See note to Table 2 regarding adjustments for discretionary reasons.

Table 5 Total landings value of cod in the Baltic Sea per fleet (1,000 DKK)

		Commercial			Less active-commercial			Total cod
Length	Primary gear	Sub 22-23	Sub 24	Sub 25-32	Sub 22-23	Sub 24	Sub 25-32	Baltic Sea
<12m	Gillnet/hook	8,897	1,007	35	1,853	730	312	12,833
	Dory/trap	205	100		480	33	4	821
	Seine/gillnet/trawl	2,544	432	2,279	480	329	92	6,156
	Trawl	1,339	362	597				2,297
12-15m	Seine/gillnet/trawl	1,239	13					1,252
	Trawl	366	1,522	1,105				2,993
15-18m	Seine/gillnet/trawl	2,573	2,531	5,087				10,191
	Trawl	3,009	3,654	7,662				14,326
18-40m	Trawl	338	886	3,249				4,474
Total		**20,509**	**10,506**	**20,015**	**2,813**	**1,091**	**409**	**55,343**

Source: The Danish Fisheries Agency Vessel Register and Sales Notes Register 9th August 2019.
Note: See note to Table 1 regarding adjustments for discretionary reasons.

The landings of herring in the western Baltic Sea comprised in total 4,095 tonnes in 2018, giving a landings value of 12.4 million DKK, cf. Table 6 and 7.

Table 6 Total landings weight of herring in the western Baltic Sea per fleet (tonnes)

		Commercial		Less active-commercial		Total herring
Length	**Primary gear**	**Sub 22-23**	**Sub 24**	**Sub 22-23**	**Sub 24**	**Baltic Sea**
<12m	Gillnet/hook	70		2		72
	Dory/trap	8	6	3	0	17
	Seine/gillnet/trawl			1	10	11
12-15m	Trawl		4			4
15-18m	Trawl	65	2,901			2,966
18-40m	Trawl		1,026			1,026
Total		**143**	**3,937**	**5**	**10**	**4,095**

Source: The Danish Fisheries Agency Vessel Register and Sales Notes Register 9th August 2019.
Note: See note to Table 2 regarding adjustments for discretionary reasons.

Table 7 Total landings value of herring in the western Baltic Sea per fleet (1,000 DKK)

		Commercial		Less active-commercial		Total herring
Length	**Primary gear**	**Sub 22-23**	**Sub 24**	**Sub 22-23**	**Sub 24**	**Baltic Sea**
<12m	Gillnet/hook	266		6		272
	Dory/trap	23	16	13	0	53
	Seine/gillnet/trawl			4	27	31
12-15m	Trawl		14	10		14
15-18m	Trawl	192	8,726			8,918
18-40m	Trawl		3,100			3,100
Total		**482**	**11,856**	**23**	**27**	**12,388**

Source: The Danish Fisheries Agency Vessel Register and Sales Notes Register 9th August 2019.
Note: See note to Table 2 regarding adjustments for discretionary reasons.

The distribution of the landings value by fleet in the western and eastern Baltic Sea is shown in Table 8 and Table 9. The dependencies vary a lot. While cod is observed to be of high importance for many fleets, only two fleets (trawlers 15-18m and 18-24m) obtain a high landings value from herring.

Table 8 Distribution of landings value on species in the western Baltic Sea, 2018

	Length	Primary gear	Cod	Other round fish	Flatfish	Her-ring	Reduc-tion species	Other species	Total landings value (1,000 DKK)
Commercial	**<12m**	Gillnet/hook	42%	0%	46%	1%	0%	11%	23,686
		Dory/trap	8%	0%	25%	1%	0%	65%	3,691
		Seine/gillnet/trawl	25%	0%	73%	0%	1%	1%	11,895
		Trawl	65%	1%	33%	0%	0%	1%	2,616
	12-15m	Seine/gillnet/trawl	25%	0%	71%	0%	0%	3%	4,916
		Trawl	26%	0%	62%	0%	12%	0%	7,336
	15-18m	Seine/gillnet/trawl	62%	0%	37%	0%	0%	0%	8,199
		Trawl	24%	0%	30%	32%	13%	0%	27,538
	18-40m	Trawl	25%	1%	10%	64%	0%	0%	4,849
Less active-	**<12m**	Gillnet/hook	37%	0%	43%	0%	0%	20%	7,031
		Dory/trap	14%	0%	20%	0%	0%	66%	3,667
		Seine/gillnet/trawl	37%	0%	55%	1%	2%	5%	2,199

Source: The Danish Fisheries Agency Vessel Register and Sales Notes Register 9th August 2019.
Note: See note to Table 2 regarding adjustments for discretionary reasons.

Table 9 Distribution of landings value on species in the eastern Baltic Sea, 2018

	Length	Primary gear	Cod	Other round fish	Flatfish	Her-ring	Reduc-tion species	Other species	Total landings value (1,000 DKK)
Commercial	**<12m**	Gillnet/hook	4%	0%	0%	0%	0%	96%	922
		Seine/gillnet/trawl	89%	0%	8%	0%	0%	3%	2,568
		Trawl	89%	0%	10%	0%	0%	0%	670
	12-15m	Trawl	91%	0%	9%	0%	0%	0%	1,213
	15-18m	Seine/gillnet/trawl	93%	0%	3%	0%	4%	0%	5,482
		Trawl	66%	0%	12%	4%	18%	0%	11,634
	18-40m	Trawl	72%	0%	28%	0%	0%	0%	4,536
Less active-	**<12m**	Gillnet/hook	38%	0%	34%	0%	0%	28%	829
		Dory/trap	100%	0%	0%	0%	0%	0%	4
		Seine/gillnet/trawl	84%	0%	16%	0%	0%	0%	110

Source: The Danish Fisheries Agency Vessel Register and Sales Notes Register 9th August 2019.
Note: See note to Table 2 regarding adjustments for discretionary reasons.

The geographical location of the vessels landing cod and/or herring from the Baltic Sea is shown in Table 9, where the vessels are registered according to the regulatory district they belong to. Most of the vessels are as expected located around the Baltic Sea or close to, i.e. Roskilde (primary harbours Gilleleje, Næstved, Nykøbing Falster, København, and Korsør), Fredericia (primary harbours Svendborg, Odense and Sønderborg) and Bornholm. In these municipalities, the fishing activities

contribution to a varying degree to the local economy through the use of the local harbours and their facilities. The importance increases with increasing distance to larger cities.

Table 10 Distribution of vessels between districts, 2018

District	Commercial vessels <12m	12-15m	15-18m	18-40m	Less active-commercial <12m	Total
Roskilde	29	7	9	2	93	140
Fredericia	26	5	8	1	69	109
Bornholm	9	3	10	3	31	56
Esbjerg	3	1	1		1	6
Nykøbing Mors		1		4	1	6
Randers					3	3
Frederikshavn	1		1			2
Total	**68**	**17**	**29**	**10**	**198**	**322**

Source: The Danish Fisheries Agency Vessel Register and Sales Notes Register 9th August 2019.
Note: See note to Table 2 regarding adjustments for discretionary reasons.

A more detailed description of where the cod and herring are landed, is presented in Table 11, where the distribution of the cod and herring landings value from subdivisions 22-24 divided on municipalities is shown, while Table 12 shows the landing distribution for cod in subdivisions 25-32. Only the 10 municipalities with the highest landings value from cod and herring in subdivisions 22-24 and 25-32 respectively, are included in the tables, which for cod in subdivisions 22-24 covers 81% of the total landings value of cod in this subdivision, while the percentage for herring in subdivisions 22-24 is 100% and for cod in subdivisions 25-32 likewise is 100%. By comparing the landings value of cod and herring from subdivisions 22-24 and 25-32 to the total landings value in the respective municipalities, an impression of the dependency originating directly for these fisheries is obtained.

Table 11 Distribution of cod and herring landings value by municipality in subdivisions 22-24 for the municipalities with highest value of landings of cod and herring, 2018

Landings of cod from subdivisions 22-24		
Municipality	Value (1,000 DKK)	Municipality dependency (%)
Langeland	6,097	31
Lolland	4,440	42
Bornholm	3,698	17
Vordingborg	2,968	22
Poland*	2,952	17
Ærø	2,359	38
Gribskov	1,936	3
Dragør	1,807	79
Rudersdal	1,305	45
Kerteminde	994	15

Landings of herring from subdivisions 22-24		
Municipality	Value (1,000 DKK)	Municipality dependency (%)
Vordingborg	5,459	40
Stevns	3,332	45
Gribskov	3,279	5
Fredensborg	259	10
Slagelse	23	0
Middelfart	11	3
Aabenraa	7	1
Faxe	7	2
Fredericia	4	1
Bornholm	3	0

Source: The Danish Fisheries Agency Vessel Register and Sales Notes Register 9th August 2019.
Note: Poland is included to show that landings here are also important.

Table 12 Distribution of cod landings by municipality in subdivisions 25-32, 2018

Landings of cod from subdivisions 25-32		
Municipality	Value (1,000 DKK)	Municipality dependency (%)
Poland	12,726	74
Bornholm	7,698	35
Stevns	0	0

Source: The Danish Fisheries Agency Vessel Register and Sales Notes Register 9th August 2019.
Note: Poland is included to show that landings here are also important.

However, as mentioned previously especially the cod fishery can give rise to bycatches of various other species. It is therefore also relevant to describe the municipality dependency on landings from the Baltic Sea.

Table 13 therefore shows how much the vessels potentially affected by cod and herring quota reductions in subdivisions 22-23 and 25-32 land to each municipality and compares this to the total landings value in each municipality. Dependency levels are generally high, except for one municipality Gribskov with the primary harbour Gilleleje. The relatively low dependency of 10% may be surprising, and will therefore be explained further. In 2018, approximately 55 million DKK of the landings value in Gribskov were from fishing in Kattegat (primarily Norway lobster 41 million DKK and plaice/sole 6 million DKK), the remaining 6 million DKK were from fishing in the western Baltic Sea (primarily herring 3 million DKK and cod 2 million DKK).

Table 13 Municipality dependency for the ten municipalities with highest landings from vessels affected by quota reductions, 2018

Municipality	Total Danish landings value all fishing areas to municipality (1,000 DKK)	Total landings value from the Baltic Sea (1,000 DKK)	Municipality dependency (%)
Bornholm	22,018	21,966	100
Langeland	19,446	19,359	100
Vordingborg	13,511	13,511	100
Lolland	10,683	10,637	100
Stevns	7,358	7,312	99
Gribskov	61,617	6,421	10
Ærø	6,225	6,225	100
Kerteminde	6,751	5,211	77
Slagelse	4,649	4,625	99
Sønderborg	5,282	3,877	73

Source: The Danish Fisheries Agency Vessel Register and Sales Notes Register 9th August 2019.

It is not possible from the available data to analyse the importance of these landings for specific processing firms. For some of these firms, even small changes in landings might have significant economic implications, if the firm's economy is fragile.

2. Financial consequences for the fishermen

Assessing the financial consequences for the fishermen following the reductions in the cod and herring quotas in the Baltic Sea will be done as a static-comparative analysis. The approach is that the calculations answer the question, what could have happened in 2018, if the cod quota in subdivisions 22-23 had been 1,337 tonnes, no targeted fishing allowed for cod in subdivision 24, a zero cod quota in subdivisions 25-32 and a herring quota in subdivisions 22-24 of 372 tonnes. The analysis will thus not consider long term effects on the profitability of the vessels/fleets following any changes in fish stocks and fleet capacity.

The calculations are based on data from the Vessels Register and Sales Notes Register hosted by the Danish Fisheries Agency and the Cost and Earnings Database hosted by Statistics Denmark. From these registers, landings data from 2018 and estimated cost data for 2018 are derived.

The financial consequences will be addressed with two scenarios indicating the expected minimum and maximum effects on the profitability of the vessels. In some situations, it might be possible for the fishermen to change their behaviour, including fishing pattern, thus reducing some of the negative effects. It is possible that some types of changed behaviour potentially can result in reduced fishing options for other fishermen, who are not fishing in the Baltic Sea. However, because the majority of the Danish fishing quotas are managed with individual transferable rights, this potential is considered limited, see also Section 4.

In the minimum repercussion scenario, it is assumed that the reduced cod and herring quota in subdivisions 22-24 and the zero cod quota in subdivisions 25-32 will only result in reduced or no landings of cod and herring respectively, and not any reductions in the potential bycatch species. Furthermore, it is assumed that cod cannot be fished in subdivision 24. However, it is assumed that the cod and herring quotas are utilised 100% in 2018. For cod in subdivisions 22-24, the observed quota utilisation was 100% in 2018, for herring it was 90%, cf. Table 14. For cod in subdivisions 25-32 quota utilization was 35%, but given that the quota is set to zero, the assumption about 100% quota utilisation does not have an effect on the landings.

In this minimum repercussion scenario, it is assumed that catches of cod can be avoided, which will require a change in fishing patterns. There are some differences in fishing seasons for the various species, with the season for cod peaking in winter and spring. However, even outside the cod season by-catches of cod cannot be completely avoided. It is therefore assumed that part of the cod quota is reserved for by-catches in other fisheries and seasons.

Table 14 Development in quota utilisation

Quota species	Subdivisions	2016	2017	2018	2019*	2020**
Cod	22-24	81.2%	85.7%	100.9%	65.7%	100%
	25-32	67.8%	73.0%	35.1%	18.5%	100%
Herring	22-24	92.4%	83.1%	73.6%	76.2%	100%

Source: The Danish Fisheries Agency.

Note: * by the 6th September 2019, ** assumed quota utilisation.

In the maximum repercussions scenario, it is assumed that not only the landings of cod are reduced, but also the landings of other consumption species are reduced as well and proportional to the reduced activity in the main fishery, except species caught with no or little expected bycatch of cod, i.e. herring, sprat, sand eel, salmon and eel. Thus, the applied reduction of bycatch species is calculated as the proportion between the estimated cod landings following from the proposed quotas in 2020, and the landings value of cod in 2018.

Comparing to the baseline, i.e. the registered landings value in 2018, Table 15 shows the expected level of landings value in the minimum and maximum repercussions scenario. In the baseline, a total landings value of 286 million DKK was observed for the included vessels in 2018, reducing to 241 million DKK with only reduced quotas, and to 228 million DKK with reduction of other relevant species also.

Table 15 Total landings value (1,000 DKK)

	Length	Primary gear	Baseline 2018	Only lower landings of reduced quotas	Lower landings of the reduced quotas and other species
Commercial	<12m	Gillnet/hook	25,943	24,148	23,141
		Dory/trap	3,691	3,543	2,991
		Seine/gillnet/trawl	19,915	17,058	16,013
		Trawl	6,456	5,420	5,080
		Total	56,005	50,170	47,224
	12-15m	Seine/gillnet/trawl	8,363	8,279	7,962
		Trawl	17,023	14,362	12,536
		Total	25,386	22,641	20,498
	15-18m	Seine/gillnet/trawl	21,740	13,974	13,076
		Trawl	98,583	78,985	74,238
		Total	120,323	92,960	87,314
	18-40m	Trawl	69,379	62,406	60,933
		Total	69,379	62,406	60,933
	Total		271,092	228,176	215,969
Less active-commercial	<12m	Gillnet/hook	8,445	7,291	6,173
		Dory/trap	3,730	3,653	3,556
		Seine/gillnet/trawl	2,577	2,100	1,906
		Total	14,752	13,044	11,636
	Total		14,752	13,044	11,636
Total			285,844	241,220	227,604

Source: Own calculations based on data from the Danish Fisheries Agency Vessel Register and Sales Notes Register 9th August 2019.

In order to calculate the financial repercussions for the vessels involved, this can only be done for the commercial vessels for which Statistics Denmark collects account statistics for. The financial effect for the less-active commercial vessels could in principle also be calculated, but due to their low activity such calculations will have to be based on strong assumptions about their cost structure. Therefore the financial analysis is limited to cover only the commercial vessels.

Description of the financial repercussions at the vessel level will be based on three indicators in form of 1) landings value, 2) gross profit: earnings defined as landings value minus operating costs, and thus portrays the surplus available for payment of crew and capital, and 3) net profit: defined as gross profit minus crew payments, and thus portrays what is left to pay off the invested capital. The gross profit is regarded the best indicator of the financial development of small vessels of less than 12 meters and some of the vessels 12-15 meters. This is because hired crew is small for these vessels, and hence the proportion of crew payments can be overestimated.

Following the reduction in landings will entail a reduction in days at sea, as well as a reduction in landings value and, consequently, have an impact on some of the operating costs undertaken, i.e.

lower activity gives rise to lower cost. These costs are fuel costs, provision and ice costs, sales costs and crew payments, which is reduced with the same proportion as the landings value. The remaining costs, i.e. insurance costs, maintenance costs, various other costs and capital costs are considered to be fixed and therefore independent of the activity level.

Table 16 shows the effect on landings value per vessel, while Table 17 and Table 18 shows the gross and net profit per vessel in the two scenarios. All indicators show that the financial performance for the various fleet will deteriorate, even if only the minimum repercussion scenario is considered.

Looking first at the landings value in Table 16, it is observed that those fleets affected mostly in the minimum repercussion scenario are those with a high dependency on cod and herring, for instance trawl below 12 meters and trawl 18-40 meters. For fleets with a lower dependency on cod and herring, these are mostly affected in the maximum repercussion scenario, for instance dory/trap below 12 meters and seine/gillnet/trawl 12-15 meters.

Table 16 Landings value per vessel (1,000 DKK)

Length	Primary gear	Baseline 2018	Only lower landings of reduced quotas	Lower landings of the reduced quotas and other species
<12m	Gillnet/hook	811	755	723
	Dory/trap	615	591	499
	Seine/gillnet/trawl	830	711	667
	Trawl	1,076	903	847
12-15m	Seine/gillnet/trawl	1,195	1,183	1,137
	Trawl	1,702	1,436	1,254
15-18m	Seine/gillnet/trawl	3,106	1,996	1,868
	Trawl	4,481	3,590	3,374
18-40m	Trawl	6,938	6,241	6,093

Source: Own calculations based on data from the Danish Fisheries Agency Vessel Register and Sales Notes Register 9th August 2019.

The effect on the average gross profit is shown in Table 17. This indicator is preferred used for fleets below 12 meters, because these fleets are primarily handled by one single fisherman. This has implications on how Statistics Denmark calculates the crew payments, which generally implies that the crew payments are overestimated compared to, what the fishermen obtain in reality. For the fleets below 12 meters, the reductions are again related to the dependency on cod and herring. The dory/trap fleet is primarily affected in the maximum repercussion scenario, while for instance the trawlers are affected mostly in the minimum repercussion scenario.

Table 17 Gross profit per vessel (1,000 DKK)

Length	Primary gear	Baseline 2018	Only lower landings of reduced quotas	Lower landings of the reduced quotas and other species
<12m	Gillnet/hook	385	341	316
	Dory/trap	219	200	127
	Seine/gillnet/trawl	299	214	183
	Trawl	500	372	330
12-15m	Seine/gillnet/trawl	415	406	374
	Trawl	859	649	505
15-18m	Seine/gillnet/trawl	1,582	734	635
	Trawl	2,675	1,954	1,779
18-40m	Trawl	3,693	3,157	3,048

Source: Own calculations based on data from the Danish Fisheries Agency Vessel Register and Sales Notes Register 9th August 2019 and cost information from Statistics Denmark.

Net profit shows what is left to pay off the invested capital, and for the fleets above 12 meters, large reductions are observed. For trawlers 12-15 meters, the net profit is reduced to one-third in the minimum repercussion scenario, and becomes negative in the maximum repercussion scenario. For the seine/gillnet/trawl fleet 15-18 meters, net profit becomes negative already in the minimum repercussion scenario, while it for the trawl fleet 15-18 meters are reduced to one-half from the baseline level to the level in the maximum repercussion scenario.

Table 18 Net profit per vessel (1,000 DKK)

Length	Primary gear	Baseline 2018	Only lower landings of reduced quotas	Lower landings of the reduced quotas and relevant bycatch species
<12m	Gillnet/hook	-71	-83	-90
	Dory/trap	-266	-266	-267
	Seine/gillnet/trawl	-47	-81	-94
	Trawl	130	61	38
12-15m	Seine/gillnet/trawl	-69	-73	-87
	Trawl	171	69	-2
15-18m	Seine/gillnet/trawl	394	-47	-98
	Trawl	1,012	621	526
18-40m	Trawl	1,471	1,159	1,094

Source: Own calculations based on data from the Danish Fisheries Agency Vessel Register and Sales Notes Register 9th August 2019 and cost information from Statistics Denmark.

Based on the calculations above, it is likely that the quota reduction and limitations on access to fishing grounds will result in a financial situation, which is not sustainable in the longer run for several

fleets. If the time perspective of a positive development in the stock abundance and quota levels are years ahead, especially the fleets below 15 meters do not have the financial robustness to cope with the rather substantial negative financial repercussions in the years until this happens. Thus they will expectedly leave the fishery and sell their fishing rights to other vessels that are not necessarily located in the same area, and which have a fishing pattern distributed on a more diverse range of fishing grounds.

Furthermore, there are the 198 less active-commercial vessels, for which it is not possible to calculate any financial performance indicators. As shown in Table 15, their total landings value will be reduced from 15 million DKK to 12 million DKK in the maximum repercussion scenario. Despite that these vessels does not fish for a commercial purpose, it is likely that such a reduction will make it so unattractive to be a less active-commercial fisherman, and many of them will have to stop fishing.

2.1 Consequences of other cod quota levels in subdivision 25-32

The proposal for the fishing opportunities in 2020 by the EU Commission the European Commission of cod in subdivisions 25-32 (eastern Baltic Sea) implied a TAC and thus a Danish quota of zero. However, in order to illustrate the potential effects of having various quota levels, a sensitivity analysis is undertaken, assuming a cod quota in subdivisions 25-32 of 500 tonnes, 1,000 tonnes, 1,500 tonnes and 2,000 tonnes respectively.

The financial consequences of the various cod quotas are shown in Table 19, Table 20, Table 21 and Table 22 including the three economic indicators, i.e. average landings value per vessel, gross profit per vessel and net profit per vessel for the baseline 2018 outcome, scenario 1 being the minimum repercussion scenario and scenario 2 being the maximum repercussion scenario.

Table 19 Financial indicators with a cod quota of 500 tonnes in subdivisions 25-32 (1,000 DKK)

		Landings value per vessel			Gross profit per vessel			Net profit per vessel		
Length	**Primary gear**	**Base-line 2018**	**Scena-rio 1**	**Scena-rio 2**	**Base-line 2018**	**Scena-rio 1**	**Scena-rio 2**	**Base-line 2018**	**Scena-rio 1**	**Scena-rio 2**
<12m	Gillnet/hook	811	755	723	385	341	317	-71	-83	-90
	Dory/trap	615	591	499	219	200	127	-266	-266	-267
	Seine/gillnet/trawl	830	729	687	299	227	197	-47	-76	-89
	Trawl	1,076	923	868	500	386	346	130	69	47
12-15m	Seine/gillnet/trawl	1,195	1,183	1,137	415	406	374	-69	-73	-87
	Trawl	1,702	1,458	1,277	859	666	524	171	77	7
15-18m	Seine/gillnet/trawl	3,106	2,137	2,014	1,582	842	746	394	9	-41
	Trawl	4,481	3,658	3,454	2,675	2,008	1,843	1,012	650	561
18-40m	Trawl	6,938	6,304	6,181	3,693	3,204	3,113	1,471	1,186	1,132

Source: Own calculations based on data from the Danish Fisheries Agency Vessel Register and Sales Notes Register 9th August 2019 and cost information from Statistics Denmark.

Table 20 Financial indicators with a cod quota of 1,000 tonnes in subdivisions 25-32 (1,000 DKK)

		Landings value per vessel			Gross profit per vessel			Net profit per vessel		
Length	**Primary gear**	**Base-line 2018**	**Scena-rio 1**	**Scena-rio 2**	**Base-line 2018**	**Scena-rio 1**	**Scena-rio 2**	**Base-line 2018**	**Scena-rio 1**	**Scena-rio 2**
<12m	Gillnet/hook	811	755	724	385	341	317	-71	-83	-90
	Dory/trap	615	591	499	219	200	127	-266	-266	-267
	Seine/gillnet/trawl	830	748	707	299	240	211	-47	-71	-83
	Trawl	1,076	942	890	500	401	362	130	76	56
12-15m	Seine/gillnet/trawl	1,195	1,183	1,137	415	406	374	-69	-73	-87
	Trawl	1,702	1,479	1,301	859	683	542	171	85	17
15-18m	Seine/gillnet/trawl	3,106	2,278	2,159	1,582	949	857	394	65	17
	Trawl	4,481	3,725	3,533	2,675	2,063	1,907	1,012	680	596
18-40m	Trawl	6,938	6,366	6,269	3,693	3,251	3,178	1,471	1,214	1,171

Source: Own calculations based on data from the Danish Fisheries Agency Vessel Register and Sales Notes Register 9th August 2019 and cost information from Statistics Denmark.

Table 21 Financial indicators with a cod quota of 1,500 tonnes in subdivisions 25-32 (1,000 DKK)

		Landings value per vessel			Gross profit per vessel			Net profit per vessel		
Length	**Primary gear**	**Base-line 2018**	**Scena-rio 1**	**Scena-rio 2**	**Base-line 2018**	**Scena-rio 1**	**Scena-rio 2**	**Base-line 2018**	**Scena-rio 1**	**Scena-rio 2**
<12m	Gillnet/hook	811	755	724	385	342	317	-71	-83	-90
	Dory/trap	615	591	499	219	200	127	-266	-266	-267
	Seine/gillnet/trawl	830	766	727	299	253	225	-47	-65	-77
	Trawl	1,076	961	911	500	415	378	130	84	64
12-15m	Seine/gillnet/trawl	1,195	1,183	1,137	415	406	374	-69	-73	-87
	Trawl	1,702	1,500	1,324	859	700	561	171	93	26
15-18m	Seine/gillnet/trawl	3,106	2,419	2,305	1,582	1,056	968	394	121	75
	Trawl	4,481	3,793	3,613	2,675	2,118	1,972	1,012	709	630
18-40m	Trawl	6,938	6,429	6,357	3,693	3,297	3,243	1,471	1,242	1,210

Source: Own calculations based on data from the Danish Fisheries Agency Vessel Register and Sales Notes Register 9th August 2019 and cost information from Statistics Denmark.

Table 22 Financial indicators with a cod quota of 2,000 tonnes in subdivisions 25-32 (1,000 DKK)

		Landings value per vessel			Gross profit per vessel			Net profit per vessel		
Length	**Primary gear**	**Base-line 2018**	**Scena-rio 1**	**Scena-rio 2**	**Base-line 2018**	**Scena-rio 1**	**Scena-rio 2**	**Base-line 2018**	**Scena-rio 1**	**Scena-rio 2**
<12m	Gillnet/hook	811	755	724	385	342	317	-71	-83	-90
	Dory/trap	615	591	499	219	200	127	-266	-266	-267
	Seine/gillnet/trawl	830	784	747	299	266	240	-47	-60	-72
	Trawl	1,076	980	933	500	429	394	130	92	73
12-15m	Seine/gillnet/trawl	1,195	1,183	1,137	415	406	374	-69	-73	-87
	Trawl	1,702	1,522	1,348	859	717	579	171	102	35
15-18m	Seine/gillnet/trawl	3,106	2,559	2,450	1,582	1,164	1,079	394	177	133
	Trawl	4,481	3,860	3,692	2,675	2,172	2,036	1,012	739	665
18-40m	Trawl	6,938	6,492	6,445	3,693	3,344	3,308	1,471	1,269	1,248

Source: Own calculations based on data from the Danish Fisheries Agency Vessel Register and Sales Notes Register 9th August 2019 and cost information from Statistics Denmark.

If the cod quota in subdivisions 25-32 is not reduced to zero, but to other levels, this will consequently reduce the negative financial consequences for fleets fishing on this quota. Logically, the more quota that becomes available, the negative financial consequences will be reduced. The tables only reflects

the implications for an average vessel in a specific fleet, but for the individual vessel, even a small quota of cod could make an important difference depending on the ability to change their fishing behaviour, cf. section 4.

3. Consequences for the onshore services and processing industry

The consequences outlined above in the minimum and maximum repercussion scenarios are expected also to have consequences for the onshore services (upstream services) and processing industry (downstream services). From the available data and modelling tools it is, however, too uncertain to calculate the impact on employment and profit for the processing industry and fishery related service industry.

In relation to the processing industry, it is complicated to analyse the effect for a specific municipality. Landings of fish to a specific harbour does not necessarily imply that it is also processed there. In the small harbours around the Baltic Sea, there is only minor processing taking place. Some of the landed fish might be sold to local fish mongers and small processing firms, but most of it is sold to larger processing firms located in other areas of Denmark or abroad. These trade-flows are impossible to describe with the current data available, and this will furthermore demand a detailed geographical economic model to capture the derived effects in relation to local, regional and national effects. Thus, the description of the potential consequences for the municipalities will therefore have to be based on the changes in landings value with the above warning in mind. Therefore, it is assumed that each vessel continues to have the same distribution of its landings to the various municipalities, and as a consequence the landings to each municipality is reduced proportional with the reduction in landings for each vessel.

Table 23 shows, which municipalities will be most influenced in the two scenarios. Especially, Bornholm, Vordingborg and Stevns will be highly impacted. These municipalities are highly dependent on landings from subdivision 24 and subdivisions 25-32. Thus, reduced fishing opportunities in these fishing areas will impact these municipalities directly. The other municipalities obtains most of their landing from subdivisions 22-23, and despite a reduction in the cod quota in these subdivisions, this will only have a limited effects on the landings value.

Table 23 Change in landings value at the municipality level (1,000 DKK)

Municipality	Total Danish landings value all fishing areas to municipality (1,000 DKK)	Total landings value with reduction only in quotas (1,000 DKK)	Change compared to baseline 2018	Total landings value with reduction in quotas and other species	Change compared to baseline 2018
Bornholm	22,018	10,625	-52%	6,555	-70%
Langeland	19,446	19,032	-2%	18,294	-6%
Vordingborg	13,511	5,593	-59%	2,577	-81%
Lolland	10,683	10,428	-2%	10,082	-6%
Stevns	7,358	3,668	-50%	2,480	-66%
Gribskov	61,617	58,521	-5%	58,454	-5%
Ærø	6,225	6,090	-2%	5,868	-6%
Kerteminde	6,751	6,694	-1%	6,464	-4%
Slagelse	4,649	4,589	-1%	4,396	-5%
Sønderborg	5,282	5,239	-1%	5,096	-4%

Source: Own calculations based on data from the Danish Fisheries Agency Vessel Register and Sales Notes Register 9th August 2019.

The onshore service industry in form of ship yards, fuel and ice suppliers etc. will likely also be affected by the lower fishing activity. Lower activity gives rise to less use of these services for maintenance and repair. The data availability for analysing these questions is almost non-existent and furthermore in the small harbours these industries is not solely dependent on the activity within the fishery, but also services provided to other types of vessels, such as leisure boats, harbour service boats, ship building etc. These other types of activities also generates an income to the harbours and to the onshore service industries.

Furthermore, some harbours may be attractive to visit for tourists, because there are activity around it, also including activity from the fishery. Reduced fishing activity and potentially fewer vessels might imply that the harbours are not so interesting to visit. This will the lead to less hotel stays, fewer meals served, less shopping etc., thus giving to even lower activity in the harbour and the town around it.

4. Possibilities for adapting the fishery

Quota reductions are made in order to recover fish stocks over time, and thus increase quotas in the future. In the long run, fleet adjustments can take place gradually in order to be at a capacity level matching the available fishing opportunities. However, in the short run, reductions in quotas will in most situations have a negative economic effect on the financial performance of the fishing vessels concerned. In order to reduce such financial effects, fishermen will try to adapt fishery and activity level in order to generate income in another way or reduce costs, i.e. they will change their behaviour if possible, given the various restrictions they are subject to.

For some of the larger vessels, an option could be to start fishing in other areas and thus other quotas, but this is not considered to be possible for smaller vessels located in the harbours around the Baltic Sea. Given the Danish management system based on individual fishing rights, such changes are only an option if these vessels buy quota from the vessels that are currently fishing in the area they would like to switch to. Changing fishing activity towards quotas not currently owned by these vessels, will imply that there is a supply at reasonable prices, which is not considered to be the case.

Cod is as mentioned often caught in the fishery conducted in the Baltic Sea and it is almost unavoidable to catch cod. Cod will thus often be a choke species that restricts the utilisation of the other quotas in the Baltic Sea. Fishermen will most likely try to adapt their behaviour to reduce the catch of cod. If this is possible the situation will be close to the minimum repercussion scenario and not the maximum repercussion scenario. Such behavioural changes might imply using other gears, fishing in other seasons, fishing in other areas of the Baltic Sea. Depending on the fisherman and the characteristics of the vessels such changes will incur a cost , else it would probably have been done already. This means that is not likely that such a change in fishing behaviour will take place. However, it is not possible based on current information to estimate the costs and gains by such a change.

Based on the above, it must be concluded that it will be difficult for these vessels to change their behaviour in a way which can counteract the negative financial repercussions of the reduced cod quota. For some, there might few possibilities, but a reduction in the number of fishing vessels must be expected quite rapidly during the coming years, if the proposed quotas for 2020 are kept at this level for several years.

Conclusion

Reducing the possibilities in the Baltic Sea for fishing cod and herring in subdivisions 22-24 and setting a zero quota for cod in subdivisions 25-32 will have financial consequences for the vessels involved in these fisheries. In 2018, the total landings value for the vessels fishing cod and herring in subdivisions 22-24 and cod in subdivisions 25-32 was 286 million DKK. If only the landings of cod and herring are reduced to the new quota levels, this will imply that the total landings value is reduced to 241 million DKK. This will then be reduced further to 227 million DKK, if landings of relevant bycatch species are also reduced together with the cod landings. The estimates show that the reduction in landings value will be between 45 and 59 million DKK, i.e. -16% and -21% respectively.

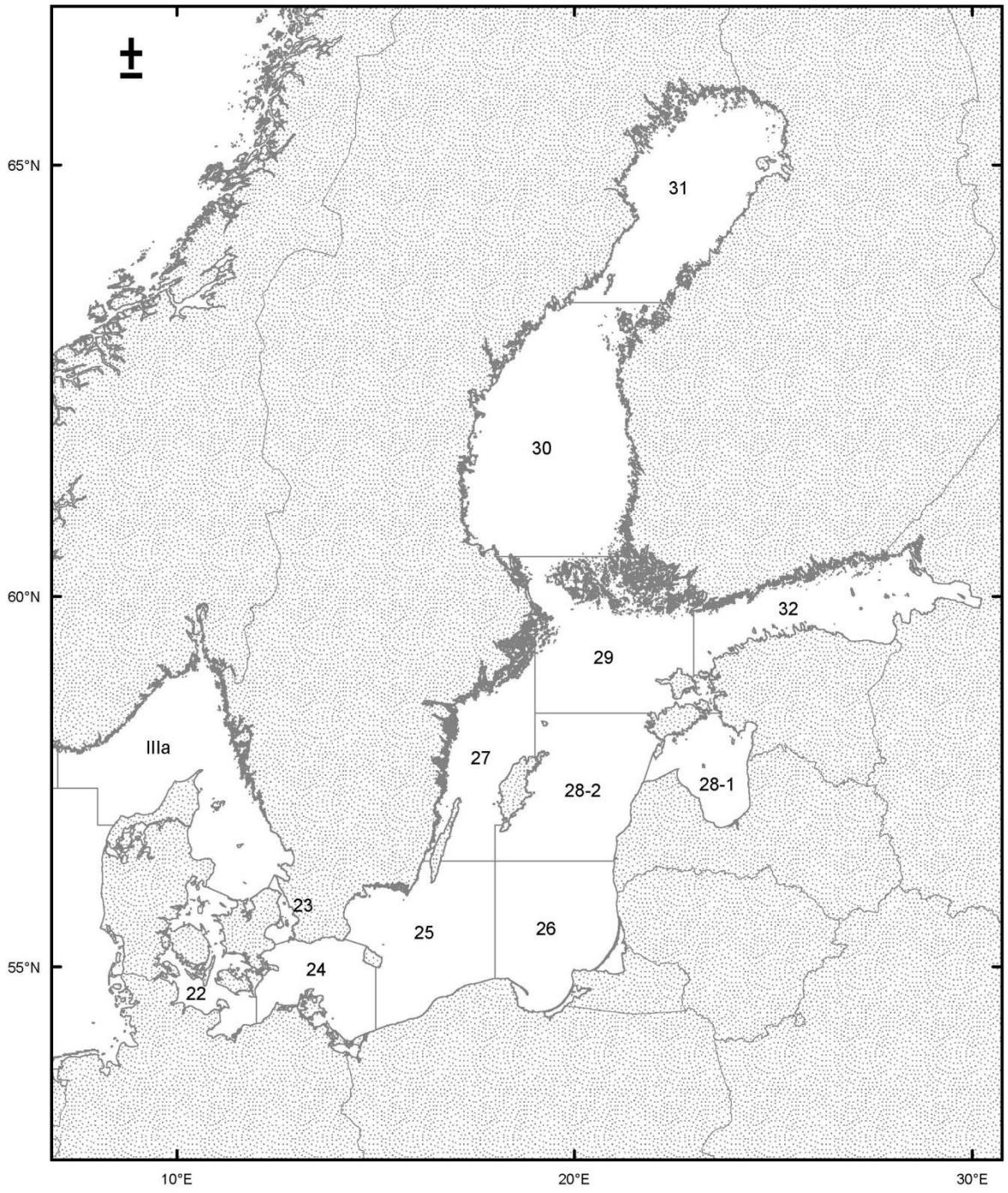
These reductions in landings value will also imply reductions in variable costs, however these will not be proportional to the reduction in landings value. Therefore, net profit will be reduced especially the smaller vessels below 15 meters, making up the majority of vessels fishing in the Baltic Sea. The repercussions will be larger, if it is not only the cod and herring landings that are affected, but also relevant bycatch species.

Maybe the consequences can to some extend be counteracted by changed behaviour, but for especially the smaller vessels it can be problematic to shift to other fishing areas or start going further to sea, if it becomes possible for them to purchase quotas in other areas. Also such behavioural changes can be costly to undertake, i.e. buying other gears, fishing on other grounds further away etc.

For onshore services and processing industry there will also be a negative effect following the quota reductions. However, it is only to a limited extend possible to analyse these effects. The amount of data and information about trade flows, processing structure, generation of work in the onshore service industry, derived effects on tourism etc. are relevant to consider, but the possibilities are currently limited to address.

For the fishing fleets, the onshore service and the processing industry, the short and long run consequences are dependent on how fast the stock situation improves. If it does not improve fast, a large number of vessels, primarily small vessels below 15 meters, are expected to leave the fishery fast, thus also having a derived effect on the onshore services and processing industry. A vessel leaving the fishery will imply a significant capital loss, because these vessels still carry a substantial amount of fixed costs.

Annex 1 Map of the Baltic Sea with subdivisions



Annex 2 Danish quota exchanges

Quota Species	Subdivisions	Exchange type	2016	2017	2018	2019*
Cod	22-24	Quantity Received	756	92	150	108
		Quantity Given	0	0	0	-3
	25-32	Quantity Received	0	0	30	50
		Quantity Given	-786	-2	-11	-24
Herring	22-24	Quantity Received	2,151	2,588	1,970	581
		Quantity Given	0	0	-550	-24

Source: The Danish Fisheries Agency.

Note: * includes exchanges until August 2019.