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Economic and Environmental Aspects of Industrial Fishery in the Baltic Sea

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Wojciech Brocki[1], Bartosz Mickiewicz[2], Wojciech Gotkiewicz[3]

Abstract:

Purpose: *The study aims to develop a science-based economic mechanism for the innovative and sustainable development of the industrial fishery in the Baltic Sea.*
Design/Methodology/Approach: *The research methodology is based on the systematic approach applied to the research of innovative development of food organizations using general scientific methods of analysis, synthesis, comparison, generalization, classification.*
Findings: *Fishing may serve various purposes, although the main one is to provide the market with fish for direct consumption. However, not all fish meet the requirements of consumers or sanitary services. Therefore, they are intended, in their unprocessed form, for non-consumption purposes, like fishmeal, oils and feed. Capture fishery of species intended for non-consumption purposes, known as industrial and feed fishery, is usually targeted at one particular fish species. The economic and natural aspects determine the nature and purpose of fishing as well. The sea is a complex ecosystem with interspecies connections called trophic network which is formed by mutually intertwined food chains.*
Practical implications: *It allows for a statement that intensive catches of one species can disrupt the functioning of other species by violating the existing food chains. Such threat is posed by intensive industrial fishery in the Baltic, which is a small sea. It may result in overfishing, which has a natural and economic effect. On the other hand, the non-fishing of species that are unprofitable for consumption fishery is a waste of protein produced by nature.*
Originality/Value: *The malfunctioning of the fish sector has an impact on the functioning of the entire economy which is a system of related and interacting elements. Improving fisheries policy improves the quality of economy as a whole. The comparison of statistical data was hampered by the changes in the data collection system in the European Union fishery, that took place in 2008, and the incompatibility of data from various EU agencies.*

Keywords: *Baltic Sea, fishing for human consumption, industrial fishery, feed fishery, prices.*

JEL Classification: *O12, O13, Q20.*

Paper Type: *Research paper.*

[1]*West Pomeranian University of Technology Szczecin, Faculty of Food Science and Fisheries, ORCID ID: 0000-0002-5238-7879, wojciech.brocki@zut.edu.pl;*
[2]*The same as in 1, ORCID ID: 0000-0002-4787-2477, bmickiewicz@zut.edu.pl;*
[3]*University of Warmia and Mazury in Olsztyn Faculty of Agriculture and Forestry, ORCID ID:* 0000-0002-3347-0549 *wgot@uwm.edu.pl;*

1. Introduction

Fish and fish products are a source of valuable, complete, easy-to-digest animal protein, contain a large amount of unsaturated fatty acids (especially omega-3), vitamin D, as well as a number of minerals, such as iodine, selenium, fluorine, magnesium, calcium. Fish may be intended for direct human consumption or for other purposes, which are mostly consumption-related too, but it is indirect in nature (fishmeal, fish oils, animal feed, medicine, etc.).

A critical analysis of the literature was performed taking into account the comparative analysis of individual countries and groups of countries with the use of descriptive statistics methods. The gathering and analysis of statistical data was carried out while taking into account the legal framework created by the directives and regulations of EU bodies (Commission, Council and Parliament). Not all Member States have followed the abovementioned legal acts on data collection and sharing. The figures on capture fishery or the utilisation of catches in countries like Finland have been far from perfect, although they were not as bad as in the case of Greece.

2. Results

2.1 Industrial Fishery Around the World

56% of fishmeal produced around the world is used for food for fish raised in aquaculture, 20% - in pig farming, 12% - in poultry farming, the remaining 12% has other application (Lassen, 2011). A relatively small amount of fish caught is used for the production of industrial oils, angling or as unprocessed feed. Hence, the notions of industrial and feed fishery are often synonymous. 67% of the saltwater fish caught around the world in the 1960s were meant for consumption purposes (FAO 2018, p. 46); in 2013-2015, 88% of fish were caught for human consumption, the rest was industrial fishery (OECD, 2018). The European Union represents 20% of the global market for fishmeal and fish oils (Lassen, 2011). It is assumed that increasing the amount of fish caught for consumption should be a lasting trend, consistent with the requirements of responsible and sustainable fishing. Industrial fishing is usually targeted because the aim is to obtain fish of a particular species. In addition, the waste by-products remaining after the processing of consumer fish, rotten fish, and often those taken off the market and those that used to be rejected are used for industrial purposes as well.

For several dozen years now, the Peruvian anchoveta has been the world's most popular fish caught for feed. Capture fishery of this species is subject to strong fluctuations associated with the cyclical occurrence of the El Niño phenomenon (Impacts... 2019). When the catches of Peruvian anchoveta fall, prices of fishmeal and fish oils on world markets start to rise, so does the pressure on industrial fishery of other fish species whose prices increase periodically. This is reflected in local

markets, including the Baltic Sea with its industrial fishery of two species of pelagic fish: herring and sprat. This causes disputes among fishermen (between those fishing for consumption and those fishing for feed), as in the southern part of the Baltic, these species are an important part of diet due to their low prices and consumer values. Until recently, the European Union considered the European sprat considered an industrial fish. Following the enlargement of the EU, which took place in 2004, sprat joined the list of consumption species. Sprat-oriented fishing in the Baltic Sea is often accompanied by large by-catches of herring.

In Finland, on the other hand, sprat is a by-catch when fishing for herring. Herring in the western Baltic Sea weighs an average of up to 220 g, in the bays of the northern part of the Baltic (subdivision 32) weighs an average of 22 g (Lassen, 2011). Both fish species interact with cod, hence the suspicion that industrial fishery for herring and sprat in the Baltic could have an impact on the condition of cod (lean cod). Discussion on whether particular fish species can and should be used for industrial purposes have been going on for years. Discrepancies have a biological, economic, social and ethical basis.

2.2 Arguments for Industrial Fishery

Intensive feed fishery can affect the balance of ecosystems. The erroneous estimation of resources and the accompanying catch limits of industrially fished species set at a too high level may affect the state of resources of other fish species in the ecosystem. Industrial fishing is mostly done by large fishing vessels that often have no connection with local fishing communities, while having an indirect negative impact on their functioning in the coastal zone. There are also ethical issues. Fish intended for fishmeal and fish oils are subjected to reduction (1 kg of fishmeal is obtained from 5-6 kg of fish, 1 kg of fish oil is obtained from 12 kg of fish) (Brocki, 2012), then they are fed as additives to feed for farm animals (including fish), which actually reduces the volume of fish protein supply on global markets. Fishmeal and oils are used in the breeding of noble fish, such as salmon, which are supplied to highly developed markets. Meanwhile, unprocessed fish used for industrial purposes could be used as food aid for poor developing countries.

However, there is a problem of costs, especially transport costs. This issue was taken into account by FAO in its Code of Conduct for Responsible Fisheries (Code... 1995). Article 11 (Post-harvest practices and trade), point 11.1.9 provides that that "States should encourage the use of fish for human consumption and promote consumption of fish whenever appropriate." This clause was interpreted as a recommendation. “In the case of abundant supplies of species of low value and in the case of high transport and storage costs, non-consumption use is possible.”

The use of these fish for industrial purposes will not allow them to be removed from the food chain in general. In addition, the industry producing fishmeal for livestock and aquaculture is, similarly, the source of jobs and food supplies. Aquaculture

provides foreign currency and is also a supplier of inland fish in areas where other sources of protein are unavailable. These factors should be taken into account when considering the use of fish for non-consumption purposes.

At the current stage, economics plays a decisive role in this respect. Although the prices of fish for consumption purposes are higher than the prices of the same species for industrial purposes, the costs of acquiring the latter are much lower. In addition to economics, market and health reasons determine the non-consumption of fish raw material as well. In the Scandinavian countries, sprat has never been a valued fish for consumption, and herring has not dominated the market of fish for consumption. If anything, it wasthe big herring from the North Sea or the Atlantic, and not the small herring from the Baltic Sea which is also more difficult to process. These are rich countries, and customers are very demanding and the price of fish is not the main factor determining its purchase.

Point 11.1.1 of the Code of Conduct for Responsible Fisheries decided that "States should adopt appropriate measures to ensure the right of consumers to safe, wholesome and unadulterated fish and fishery products." In highly developed countries, the health aspects of food consumption are very important. Quality issues dominate over quantitative ones. This, in turn, poses a problem of the level of dioxin in fish caught in the Baltic Sea. In the Baltic Sea basin, the highest level of dioxins taken from food occurs in the countries with high fish consumption. In Finland, 63% of dioxins come from fish consumption, in Sweden – 34%, and in Poland – only 7%. For comparison, in Norway, it is 46%. There is a visible correlation of the dioxin content, polychlorinated biphenyls (PCBs), mercury and lead in food with the level of fish consumption (Assessment... 2019). Dioxins accumulate in fish with high fat content, such as herring and sprat, in long-living fish, such as cod, and especially in long-living fatty fish like salmon. The consumption level of noble fish such as cod and salmon is relatively low, so their consumption does not pose threat to health.

The consumption of herring and sprat is higher, hence the greater health risk. In the south-western Baltic and Danish waters, the average dioxin content in herring was 2-2.5 nanograms (Ng) per kilogram of fresh fish. In the Baltic Proper and in the Gulf of Finland, this level was twice as high, in the Gulf of Bothnia and in the Bothnian Sea this level was four times higher. The further north, the smaller the impact of nutrient infusions from the North Sea, cleansing the waters of the Baltic Sea. The level of dioxins exceeded the EU standards adopted for food and animal feed. However, it was acceptable for fishmeal and fish oils processing (Lassen, 2011).

2.3 Feed Fishery in the Baltic Sea

There are two countries in the Baltic Sea that have well-developed fish processing oriented towards non-consumption production. Denmark is the leader in this respect, with an average number of fish landings for non-consumer purposes in the years 2007-2019 in the amount of 686 thousand tons, of which 364 thousand tons came

from landings from own fleet vessels, as presented in Table 1. The second largest fish supplier in this respect for Danish processing plants in 2007-2019 was Sweden with its 92 thousand tons, then Norway (74 thousand tons), Germany (22 thousand tons) and Poland (21 thousand tons). The average annual landings of Ireland, Lithuania and the United Kingdom were at the level of 10-15 thousand tons. Finland unloaded 8 thousand tons of fish in Denmark. Latvia and Estonia provided marginal amounts.

Another country in the Baltic Sea basin that processes significant quantities of raw fish for non-consumption purposes is Sweden whose harbours unloaded an annual average of 75,000 tons of fish for non-consumption purposes in the years 2007-2019, out of which 45,000 tons came from landings from domestic fleet, over 2,000 tons from Poland and under 1 thousand tons from Germany, Latvia, Lithuania and Estonia, i.e. from local Baltic deliveries. When taking into account landings for feed purposes of all countries in the Baltic Sea basin, in 2007-2019, 53% of the landed fish was used for feed purposes (Table 1). The picture is distorted by Denmark, Sweden and Germany, or countries whose majority of landings came from fishing in the North Sea that is a more attractive reservoir for fisheries than the Baltic Sea. These countries find cod to be the most attractive fish caught in the Baltic Sea; the cod (and herring in smaller amounts) constitutes the majority of fish caught in the Baltic Sea for consumption purposes. The picture is also distorted by the weakness of Eurostat statistics, that described the 2014 landings in Finland at the level of 31 thousand tons, while STECF statistics reported catches of 148 thousand tons (Scientific... 2017), and ICES statistics – 154 thousand tons (including 130,000 tons of herring and 12,000 tons of sprat and 0.4 thousand tons of cod) (ICES... 2018).

On the basis of Eurostat data, this study estimated Finnish landings for non-consumption purposes by summing up landings in Danish and Swedish ports. The difference between total landings and non-consumption landings allowed to estimate the number of landings. Landings in Finland for non-consumption purposes were surely higher than 700 tons (2014), if there had been years when 10,000 tons had been significantly exceeded, as shown in the table. The EU study 'Industrial Fisheries in the Baltic Sea' (p. 46) estimated that all sprat and 60-70% of herring landed in Finland are destined for industrial purposes. If Finnish fishing figures were equivalent to landings, it would give around 80,000 tons of fish designated in 2014 for non-consumption purposes. It is possible that this fish was being reloaded at sea on ships of other fleets, as there is no trace of landings for human consumption in another Baltic Sea country.

The item *Other landings* shown in Table 1 covers all non-consumption uses, mainly for industrial purposes. In addition to industrial fishery for feed purposes, the remaining items of non-consumption utilisation were relatively rare in the statistics, with the exception of the figures for Poland between 2007 and 2011 – they constituted an unknown type of utilisation.

The above estimates tell us that at least 230 thousand tons (including Finland) was allocated for industrial purposes in 2019, which accounted for 40% of the fish from total 572 thousand tons caught in the Baltic Sea. When we exclude Finland (fishing and the use), the percentage was similar, as it amounted to 41% (175 thousand tons intended for industrial purposes) out of 424 thousand tons caught by the remaining countries in the Baltic. Finnish fishing statistics on landings are similar in nature to Greek statistics – in both cases, one can imagine the state of affairs, but no one shows it explicitly or at all. It is no secret that herring caught by the Finns is of low consumption value and it would be difficult to sell it for non-industrial purposes, however, hiding it from the international community is reprehensible.

According to their own estimates, the authors believe that the following countries had the largest share in the Baltic Sea industrial fishery: Sweden (about 80,000 tons), Finland (about 80,000 tons), Denmark (about 40,000 tons), Poland (about 20,000 tons) and Germany (about 10-15 thousand tons). In countries having access to the North Sea, cod is the most desirable Baltic consumption fish, small amounts of Baltic herring are allocated to meet the needs of local communities, the rest has been allocated for industrial purposes, as the bigger herring from the North Sea was the basic raw material in large processing plants of fish for consumption. On the other hand, the entire population of Baltic sprat was used for industrial processing.

2.4 Prices of Fish for Industrial Purposes in the Baltic Sea

The fish processing industry has certain production capacity and its full exploitation nmakes it possible to achieve favourable economic results and consistency of markets. In the case of Denmark, huge amounts of fish landed at ports located on the west coast play the part, as well as in Skagen and the Skagerrak area. This requires the continuity of supply of fish raw material at the level of about 700,000. tons per year. The elimination of the associated risk comes at a price – it entails a rise in the prices of fish for industrial purposes, as shown in Table 2. The prices for non-consumption fish in Denmark were similar for fishermen from all countries landing fish in Danish ports. They fluctuated between EUR 230-320 per ton (Table 3). For Polish and Lithuanian fishermen, the nearest port for unloading fish in Denmark is Nexø, Bornholm, where 4% of non-consumption fish landings in Denmark are made (Lassen, 2011). There is a noticeable relative stability of average prices of consumption fish landed in Denmark, although we can observe two opposite trends when analysing the prices of fish from Norway and Poland. The prices of Norwegian fish in the years 2007-2019 increased by over 100%, while prices of consumption fish from Poland decreased six-fold. This can be explained by the change in the species structure of Danish landings, as a result of the deteriorated quality of Baltic cod (lean cod), it could be replaced by the cod coming from Norwegian fisheries. Polish landings, on the other hand, became dominated by low-valued fish species (e.g. herring), as indicated by the low price.

Table 1. *Landings intended for consumption and non-consumption in the countries of the Baltic Sea basin in the years 2007-2019*

Country	Loads	Place of origin	Year										2007-2019 average	2019/2007 %
			2007	2008	2009	2010	2011	2012	2013	2014	2015	2019		
Danmark	total		1063873	984766	1054957	1066559	911255	614137	848940	993294	115881	897105	959367	84,3
	consumption		368083	309468	279858	244079	228399	254223	255966	262434	266609	266917	273604	72,5
	other		695790	675298	775099	822480	682856	359914	592974	730860	892172	630188	685763	90,6
		Danmark	359927	423275	503205	540547	447095	206457	358007	415751	186967	194395	363563	54,0
		Norway	123122	49135	13340	11016	46016	35541	74737	167083	149712	69826	73953	56,7
		Sweden	99730	108290	107368	122292	91762	51254	80663	70266	102537	84776	91894	85,0
		Poland	24375	20742	37972	19572	23563	13945	24064	8614	23906	15670	21242	64,3
		Germany	17091	23904	33073	28868	24855	13226	19460	16999	25280	20303	22306	118,8
		Lithuania	16492	14102	23911	9964	12888	11321	11597	9943	10430	12297	13295	74,6
		Finland	15596	15517	12422	14740	13666	154	1600		375	1150	8358	7,4
		Irland	5831	2456	29168	38552	7342	19486	9988	9401	1152	5771	12915	99,0
		Great Britain	22911	12756	4105	13851	10923	5583	5034	19652	12213	16320	12335	71,2
		Latvia	4253	2947	6167	7613	3665	126	190	368	801	2593	2782	61,0
		Estonia	1823	536	1170,1		270,3				694	911		50,0
	other/total (%)		65,4	68,6	73,5	77,1	74,9	58,6	69,8	73,6	77,0	70,2	71	107,4
Estonia	total		76726	83143	88843	87373	70842	63993	64966	63220	63250	59648	72200	77,7
	consumption		76725	83044	88742	87301	70769	63920	64916	63157	63250	59648	72147	77,7
	other	Estonia	1	99	101	72	73	73	50	64	0	0	67	0,00
	other/total (%)		0,00	0,12	0,11	0,08	0,10	0,11	0,08	0,10	0,00	0,00	0	0,00
Finland	total		17650	19170	18043	19397	24334	29089	35165	30833				0,00
	consumption		2054	3653	5457	1783	9973	28935	33366	30111				0,00
	other		15596	15517	12586	17614	14361	154	1799	722				0,00
	other/total (%)		88,4	80,9	69,8	90,8	59,0	0,5	5,1	2,3				0,00
Lithuania	total		15293	7532	9128	5536	6391	3467	2532	1977	2026	2253	5614	14,7
	consumption		15293	7352	9128	5536	6391	3467	2532	1977	1942	2201	5600	14,4
	other		0	0	0	0	0	0	0	0	84	52	0	
Latvia	total		80998	85767	71531	67134	59317	59844	65357	61626	66010	60173	6776	74,3
	consumption		80998	85767	71531	67134	59317	59844	65357	61626	66010	60173	6776	74,3
	other		0	0	0	0	0	0	0	0	0	0	0	0,00
Germany	total		113138	101344	92643	80086	117358	107055	98678	105842	106934	118792	104187	105,0
	consumption		112397	100033	91342	78621	116206	106066	97631	105060	105820	114624	102780	102,0
	other	Germany	741	1311	1301	1465	1152	989	1047	782	1124	4168	1407	562,5
	other/total (%)		0,7	1,3	1,4	1,8	1,0	0,9	1,1	0,7	1,1	3,5	1	535,7
Poland	total		79054	65790	80147	84013	88034	105420	102902	109344	113690	121986	94994	154,3
	consumption		47001	65790	80147	84013	55068	101109	95902	109233	113170	121824	87326	259,2
	other		32053	0	0	0	32966	4311	6557	111	520	162	7668	0,5
		Poland						4311	6557	111	520	162	162	0,00
	other/total (%)		40,5	0,00	0,00	0,00	37,4	4,1	6,4	0,1	0,5	0,1	9	0,3
Sweden	total		242223	226982	216591	220923	171329	108745	126463	101824	88394	93356	159683	38,5
	consumption		112909	100332	87093	73597	76630	102434	90121	71961	66555	68472	85010	60,6

	other		129314	126650	129498	147326	94699	6311	36342	29863	21839	24884	74673	19,2
		Denmark		105976							4	2	51268	0,0
		Sweden	99089	12803	112407	129124	87543	1269	29778	22797	15671	22072	45255	115,7
		Poland	19085		4730	7097	826	1633	2847	708	378	119	2292	0,0
		Germany		14	1463	934	168			383			502	0,0
		Finland	51		164	2874	695		199	722	5286	991	1562	0,0
		Estonia			537,8	2,1					181	1093	453	0,0
		Latvia			690,2	165,3							428	0,0
		Lithuania			314					296	229	373	303	0,0
	other/total (%)		53,4	55,8	59,8	66,7	55,3	5,8	28,7	29,3	24,7	26,7	47	49,9
Baltic States - total	total		1688955	1574494	1631883	1631021	1448860	1091750	1344560	1467961	1599085	1353313	1483188	80,1
	consumption		813406	751966	707841	640281	612780	691063	672425	675448	683356	693859	694243	85,3
	other		875549	822528	924042	990740	836080	400687	672135	792513	915729	659454	788946	75,3
	other/total (%)		51,8	52,2	56,6	60,7	57,7	36,7	50,0	54,0	57,3	48,7	53,2	94,0

Source: *Compiled on the basis of Eurostat data.*

The non-consumption fish landings saw a fairly stable price increase, which encouraged fishermen to fish. In the years 2007-2019, the prices in Poland increased by 72%, and in Denmark – by 79%. The upper limit of the price level is defined by the profitability threshold for the processing plants, and the lower limit – by the profitability of fishing. These prices were very favourable for fishermen from the new EU countries. Polish fishermen on Bornholm got prices twice as high as when unloading the same fish in their own country. This explains the strong pressure of owners of pelagic fishing vessels for industrial fishery, which is reflected in the high use of catch limits for herring and sprat, as shown in Table 4.

Table 2. *Fish prices on the Danish market in the years 2007-2019,by country of origin and utilisation [euro/ton]*

Countries-suppliers	Year										2007-2019 Average	2019/2007 %
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2019		
Total												
Average of all suppliers	472	439	342	433	543	694	543	451	456	624	500	132,20
Denmark	546	480	367	458	565	764	565	480	483	701	541	128,39
Poland	149	114	117	126	218	215	284	222	223	244	191	163,76
Norway	298	360	459	651	529	543	439	277	362		435	0,00
Cinsumption fishes												
Average of all suppliers	1038	1103	946	1207	1478	1284	1149	1136	1207	1442	1199	138,92
Denmark	1164	1259	1063	1312	1511	1307	1149	1169	1230	1487	1265	127,75
Poland	1412	1049	382	902		285		232	230	229	590	16,22
Norway	476	542	542	805	1049	945	845	730	969	970	787	203,78
Other fishes												
Average of all suppliers	173	135	123	203	231	270	279	205	233	280	213	161,85
Denmark	155	132	120	207	221	282	269	203	232	278	210	179,35
Poland	140	110	116	126	218	215	284	222	223	241	189	172,14
Norway	204	136	138	231	281	247	287	193	252	320	229	156,86

Source: *Compiled on the basis of Eurostat data.*

Table 3. *Prices of fish landed in Denmark and Poland in 2019, by utilisation and country of origin[euro/ton]*

Utilisation						
Country	Denmark			Poland		
Country of origin	Total	Consumption	Others	Total	Consumption	Others
EU 27	657,96	1489,97	273,18	416,22	416,40	305
EU 15	676,0	1490,65	275,04	1338,02	1338,02	-
Denmark	701,0	1486,95	278,95	1383,95	1383,95	-
Germany	844,11	2445,01	269,25	878,39	878,39	-
Estonia	235,2	426,83*	230,24	710,56	729,46*	-
France	1787,0	1787,76	268,79	-	-	-
Ireland	315,77	1873,85	302,01	-	-	-
Latvia	247,83	945,13	234,53	984,59	984,59	-
Lithuania	240,54	644,21	240,54	428,05	428,05	-
Poland	240,54	229,04	241,06	389,86	390,02	305
Finland	243,96	361,62	243,94	1251,10	1251,10	-
Sweden	371,23	942,70	256,76	975,75	975,75	-
Great Britan	779,93	1304,15	295,07	-	-	-
Norway	490,13	970,30	320,17	-	-	-
Other countries	326,72	1659,08	301,02	-	-	-
Fatoe Islands	302,75	1081,37	301,34	-	-	-
Greenland	425,56	1708,16	299,61	-	-	-

Note: **2017.*
Source: *Compiled on the basis of Eurostat data.*

2.5 Impact of Feed Fishery on Reaching the Catch Limits in the Baltic Sea

Two conditions should be met to ensure that fishing limits are utilised to a large degree, there must be fish and fishery must be bring profits. These conditions are best met in the case of pelagic catches of sprat, where the implementation of TAC (Total Allowable Catches) in the Baltic Sea in the years 2012-2019 was close to 100% (Table 4). In the case of herring, the TAC implementation was 87%, which is a satisfactory result as well. This means that industrial fishery in the Baltic Sea was profitable.

There is, however, the other side of the coin. If you take into account the food links between these four species, it may turn out that in the long term, industrial catches of sprat and herring were made at the expense of potential stocks of cod and salmon. The condition of maximum sustainable catch of all fish species must be met. We need to keep in mind that herring and sprat are not the only cod food.

Over fishing of species not covered by the limits, e.g., sand lances, poses threat to cod stocks. The ruthless exploitation of these species may result in the seemingly safe level of TAC for industrial fish not providing enough food for cod and salmon which is consumed in large amounts by seals. Salmon would face a double threat,

lack of food and an increase in the number of predators hunting it. The level of implementation of the TAC for salmon was at 60% and cod – under 50%, which was due to the poor state of the stocks of these species.

Table 4. *Utilisation of TAC for the four basic fish species in the Baltic Sea between 2012 and 2019 [%]*

Species	Year	Germany	Denmark	Estonia	Finland	Latvija	Lituania	Poland	Sweden	Average
Cod	2012	63,0	78,0	54,0	90,0	59,0	53,0	68,0	61,0	65,75
	2013	37,0	52,0	15,0	32,0	38,0	40,0	60,0	36,0	38,75
	2014	45,0	55,0	10,0	24,0	31,0	24,0	55,0	30,0	34,25
	2015	60,0	82,0	12,0	36,0	55,0	46,0	75,0	43,0	51,13
	2019	76,0	82,0	0,0	10,0	68,0	64,0	83,0	54,0	54,63
	Average	56,2	69,8	18,2	38,4	50,2	45,4	68,0	44,8	48,90
Salmon	2012	48,0	80,0	40,0	85,0	55,0	7,0	75,0	100,0	61,25
	2013	86,0	93,0	45,0	73,0	18,0	7,0	104,0	92,0	64,75
	2014	44,0	95,0	41,0	83,0	13,0	9,0	48,0	95,0	53,50
	2015	99,0	78,0	46,0	87,0	22,0	8,0	62,0	100,0	62,75
	2019	73,0	48,0	52,0	84,0	5,7	23,2	60,5	109,0	56,93
	Average	70,0	78,8	44,8	82,4	22,7	10,8	69,9	99,2	59,84
Herring	2012	89,0	65,0	90,0	90,0	89,0	71,0	98,0	88,0	85,00
	2013	92,0	101,0	89,0	96,0	87,0	68,0	79,0	88,0	87,50
	2014	92,0	94,0	85,0	87,0	92,0	57,0	78,0	79,0	83,00
	2015	98,0	46,0	87,0	74,0	98,0	85,0	87,0	70,0	80,63
	2019	127,0	120,0	99,7	99,0	73,4	100,0	92,4	67,2	97,34
	Average	99,6	85,2	90,1	89,2	87,9	76,2	86,9	78,4	86,69
Sprat	2012	100,0	98,0	99,0	83,0	100,0	100,0	95,0	99,0	96,75
	2013	100,0	91,0	100,0	97,0	100,0	100,0	106,0	100,0	99,25
	2014	92,0	88,0	95,0	93,0	94,0	92,0	94,0	97,0	93,13
	2015	98,0	95,0	89,0	100,0	97,0	96,0	97,0	100,0	96,50
	2019	86,5	95,5	102,0	160,0	100,0	114,0	99,8	109,0	108,35
	Average	95,3	93,5	97,0	106,6	98,2	100,4	98,4	101,0	98,80

Source: *Compiled on the basis of ICES data.*

Of course, there might have been some other reasons for "lean cod" too. Between 2007 and 2012, the weight of cod decreased by 30%. It could have been influenced by the progressive warming of the Baltic Sea waters, water pollution, changes in the chemical composition of waters, the decreasing salinity of water, the decrease in oxygen content in water, the migration of shoals (the sprat stock moves up the Baltic for food, and cod requires depths that are immobile). In the past, the weight of herring and sprat decreased by as much as 40-60%, but this was due to the excessive density of the shoal.

The status of sprat and herring stock depends not only on the level of exploitation of such resources by humans, but also on their interaction with cod, as well as on hydrological conditions. This applies in particular to the temperature of the water

during spawning and larval development. From a technical point of view, industrial pelagic fishing does not pose a threat to the environment, it is not damaging to the bottom and ensures satisfactory selectivity. However, you cannot treat the Baltic Sealike a typical fish farm that can be accessed by anyone who has such a need. The Baltic is a small sea, designated as "Particularly Sensitive Sea Area" (status given by the International Maritime Organization (IMO) to areas of special ecological, social, cultural and scientific importance). Due to their particular sensitivity, these areas may be vulnerable to damage (Brzezinski, 2017).

The small sea is a scene of numerous conflicts, including the problem of the co-existence of industrial and consumption fishing. The first step in this direction should be to limit the size of fishing vessels fishing in the Baltic Sea. The idea of industrial fishery is justified, as it prevents the wastage of valuable fish raw material, while the method of its implementation should ensure the achievement of maximum sustainable fishing of all species caught in the Baltic (not only those covered by the TAC) and to enable equitable opportunities for all fishermen. This requires better cooperation between politicians and scientists and fishermen.

3. Discussion and Conclusion

Feed fishery is not a negative phenomenon, provided that it meets certain conditions. The first condition is the form, the second one is the scale. If both conditions are met, it does not interfere with the functioning of the ecosystem. Feed fishery should not be carried out in a zone with economically weak coastal fishery, because it constitutes strong, even unfair competition for such fishery. One cannot forget about the social aspect of these catches either.

Landings in distant ports mean that they simply have no impact on the economic activation of local communities compared to coastal fishing. Feed fishery should be conducted taking into account the requirements of the maximum stabilized catch, taking into account all fish species living in a given ecosystem (not only those that fishermen have interest in, e.g.

Capture fishery of herring and sprat in the Baltic Sea is suspected of being responsible for the disastrous level of cod stocks. It is necessary to take into account the fact that not only the quantities of species fished for feed purposes determine the level of cod stocks in the Baltic Sea, but also the time and place of catches. In the case of countries that joined the EU in 2004 (especially Poland), sales of fish intended for fodder in Denmark are incomparably more profitable (prices and scale of sales) than for consumption purposes on domestic markets.

Hence, there is a strong pressure on catches of sprat intended for fodder in the central and south-eastern parts of the Baltic Sea. Therefore, strict legal regulations on feed fishery in the Baltic should be introduced.

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