

Herring – An alternative to decreasing Baltic cod quotas ?

- Model-based analysis of the profitability of herring fishery

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Abstract. The very restrictive quotas of cod in the Baltic Sea are a strong force for searching alternatives. Since 1996 for instance, the cod quota for the German fishery was reduced from 22 000 t to 13 000 t in the year 2001. And further cuts took place in 2002. However, concerning the Baltic herring, its populations developed well. Nevertheless, the German quota has been used only by 13% because of marketing problems. But these difficulties will be reduced by establishing a new fish processing plant on the island of Ruegen in the near future. Therefore the regional government of Mecklenburg-Western Pomerania and a PO of Ruegen took an initiative to investigate the possibilities of a revival the spring herring fishery. Before the German unification in the former German Democratic Republic herring fishing was carried out to a great extent. At this Conference we present a paper to estimate, under which biological and economic conditions the spring herring catch can be an economic alternative for cod fishing in the Baltic Sea for a special fleet segment located in Saßnitz. For this purpose we use a mixed integer simulation model built up and funded by EU in a FAIR-Project. It has now been adapted to the conditions of Baltic herring fishery with 26.5 m German bottom trawlers. Different cost items and returns (prices, catches) can be correctly modelled as activities of linear programming.

Keywords: Fishery Management, Quotas, Baltic, Cod/herring

1. INTRODUCTION

The fishery in the Baltic Sea is strong dependent from only a few fish species. The main target species is cod with a share of 80 until 90% concerning the returns of certain fleet segments. Additionally their mostly small boat size and engine power is limiting the fishing grounds which can be touched at. Their activities are limited to the Baltic Sea. Therefore the catch quota reduction strikes particular hard this fishery. Faced with the worrying problem of dwindling fish stocks within the last five years the allotted quota was reduced year by year, specially for the target species cod.

Before the reunification of Germany West and East Germany in 1990 herring fishery at the spring spawning season was the usual fishery of the local enterprises. State-fixed fish prices at a high level, specially for herring, guaranteed a sure income for these fisheries in those days. The herring was sold to the regional and national fish processors or exported. After 1990 the herring fishery such as the local fish processing industry collapsed faced with the fish market globalisation. Neither the predominant small and medium scale inshore fishing nor the small scale regional processing plants were competitive to the rest of the globalised national and European fish markets. As the cod quota was fully used the last years, the utilisation of the herring quota is diminishing down to about 10% only.

In this context this investigation should check, under which conditions the herring fishery of a special fleet segment of Saßnitz is economically meaningful. These advisements are supported by building up a herring processing plant near by the harbour of Saßnitz funded by the Financial Instruments for Fisheries Guidance (FIFG) of the European Union (EU) and newly-formed Federal State Mecklenburg-Western Pomerania (MWP) in the form of a pilot and demonstration project.

2. GEOGRAPHICS AND ECONOMICS OF MECKLENBURG-WESTERN POMERINIA

The federal state MWP is geographically the most east situated state of the Federal Republic of Germany and one of the economically least developed countryside of Germany.

With regard to the evaluation of the economic situation of a region or their households the per capita income is a well-known indicator. 1998 MWP achieves with 9377 € only about half compared with 19864 € of the whole of Germany (Agrarbericht MWP, 2001). The shape of unemployment is with 19.4% twice as high as the average of

Germany. Faced with only 77 habitants per km² compared with 230 all Germany, in this region agriculture and forestry play a major role in the economic and social fabric with a comparatively high share of persons employed in. In certain coastal areas up to 7% of the working people are directly dependent from fishing. Such a region is the Island of Rügen. The regional unemployment particularly on Rügen reaches from 16% to 24%. Only the tourism offers possibilities of temporary occupation in summer holidays in this economically underdeveloped country.

3. QUOTA MANAGEMENT AND UTILISATION

The most important regulation in the German fishery is in form of an output regulation the catch quota management. The total catch quotas (TAC) of the Baltic Sea are assigned on yearly basis by the IBSFC advised

Table 1: TACs, quotas of cod and herring and their utilisation for Germany and Mecklenburg-Western Pomerania, 1991 - 2002

Herring in t							
	1991	1997	1998	1999	2000	2001	2002
TAC IBSFC	402 000	560 000	560 000	476 000	405 000	300 000	200 000
Quota EU	85 450	297 700	299 700	254 560	218 550	157 850	106 400
Quota GER	61 280	97 450	97 450	82 841	70 486	51 261	34 807
Landings GER	15 765	12 755	9 510	10 069	9 443	11 384	21 000
Utilisation	26%	13%	10%	12%	13%	22%	ca. 60%
Quota MWP*	61 280	97 450	97 450	82 841	70 486	51 261	34 808
Landings MWP	9 343	10 065	7 309	7 136	6 477	8 628	12 800
Utilisation	15%	10%	8%	9%	9%	17%	37%

Baltic Cod in t							
	1991	1997	1998	1999	2000	2001	2002
TAC IBSFC	171 000	180 000	140 000	126 000	105 000	105 000	76 000
Quota EU	59 260	112 452	86 547	77 434	64 262	66 045	46 284
Quota GER	14 428	21 638	16 846	15 156	13 407	12 862	9 127
Landings GER	7 339	14 117	10 872	14 924	12 662	12 190	
Utilisation	51%	65%	65%	98%	94%	95%	
Quota MWP	-	6 284	4 988	4 551	4 061	3 942	2 738
Landings MWP	2 773	3 794	3 556	4 638	4 061	3 906	
Utilisation	-	60%	71%	102%	100%	99%	

Sources: TAC/quotas: EC regulations; utilisation: BLE; Annual Reports on Agriculture of Mecklenburg-Western Pomerania 2000, 2001 and 2002; Annual Reports on German Fisheries, 1997-2002; Landesamt für Fischerei Mecklenburg-Vorpommern

the cod quota vessels with a maximum length over all (LOA) of 10 metres which form part of a PO are to be allocated the corresponding quota share to the PO. Non-organised, independent fishermen are fishing on an overall quota for these group of fishermen at all. Vessels with more than 20 metres LOA have a vessel allocated quota independent of their membership to a PO.

Boat less than 10 metres overall length (LOA) acting mostly in passive fisheries (gillnet, set-net) near the coastal line as part-time occupation or extensively. This group of vessels amount only around 3 % of the total landings of Germany and 6 % of the landings of the German coastal and cutter fleet. Nevertheless in certain regions and periods within the year their largely single species landings, mainly herring and partly cod, have a share of more than 60%. 80 % of the German fishing fleet are in this group (boats less than 10 m LOA). In the eastern federal state MWP its share reaches the 90% mark (see table 3). The group next in size (up to 20 metres LOA) has quotas allotted to a definite vessel. To push forward the Fish PO's and make them more flexible it is allowed to them to transfer quotas within their organisation if the total quota of all members is not fished out. The cutter group with more than 20 and less than 30 m LOA have an individual not-transferable quota independent of the PO membership. All of them are full-time fishermen with one or two additional employees.

The basis for the yearly allotment to the vessel or PO is their „historical“ landings. National cuts follow proportional cuts at vessel or PO level. How the quotas of Baltic cod and herring and their shortages developed in the previous year and about which share the quotas were utilised see table 1.

Within the last years the German Baltic Sea cod quota had been cut year by year corresponding to the declining stock biomass (see table 2). The cod (*Gadus morhua*) in the Baltic Sea (IIIb,c,d) is divided in two separate stocks, based on genotypic and phenotypic characteristics. These are the Central & Eastern (sub divisions 25-32) and the Western (sub-divisions 22-24) cod stocks, located east and west of Bornholm, respectively. In the Eighties around 94 % of the overall Baltic sea stock was composed of the eastern stock (in 2000 about only 77 %). In time the eastern stock is considered to be exploited outside safe biological levels. Worse recruitment conditions due to the low influx of saline water from the North Sea are worrying additionally. The allowed Baltic

by the ICES working groups. In the next step the EU-Fishery council distributes this TAC as quotas among the coastal member states of the Baltic Sea Germany, Sweden, Denmark, Finland, Russia, Poland, Estonia, Latvia and Lithuania concerning the regional situations of the stocks in the Baltic waters. The fixed catch quota by species is then shared by traditional rates among the two German Federal states Schleswig-Holstein (SH) and Mecklenburg-Western Pomerania (MWP) bordering the Baltic Sea by the national administration BLE (Bundesamt für Landwirtschaft und Ernährung). The manner of the assignment of the permit and specially of the quota depends on the vessel size and whether the single fisherman respectively his enterprise is a member of a Producer Organisation (PO). Accordingly to the most important Baltic Sea quota

Sea cod TAC declined on about the half from 1998 to 2002 (140 000 to 76 000 t, table 1). In future further shortages are expected. Previous years a constant cod share of 30 % of the total German cod quota was allotted to MWP and has been fished out nearly totally, unlike to herring. The high cod preference of the Baltic fishery is pushed by high prices compared to the alternative species herring and flounder (see figure 2). Whereas the share of the non quoted flounder -mainly caught as by-catch to cod - increases since 1996 year by year, supported by a good sales potential in a specialised market segments, the herring quota is exploited only slightly with 10 until 22% before 2002 (see table 1). Seasonal harvest, missing or worse marketing chances (missing shore based fish processors), no food industry for fish meal production and last not least a fairly sufficient cod quota bar from a better utilisation of the herring quota. In addition the fish industry prefers the North Sea herring for the production of half- or end-products for the human consumption because of the worse processing quality of the Baltic Sea herring (consistence, compounds like fat content and length). Chances take place since starting a EU funded pilot- and demonstration project. The herring landings increase continuously so that the German herring quota (in time there is no individual vessel herring quota for MWP) is utilised to about 63% till June of the current year.

Table 2: Cod landings of the Western and Central/Eastern Baltic Sea

ICES sub-division	22 + 24 (Western stock)				25 - 32 (Eastern stock)				total	
	landings		SSB		landings		SSB		landings	SSB
	in tons	in %	in tons	in %	in tons	in %	in tons	in %	in tons	in tons
1984	19 641	38	46 060	7	32 276	62	648 120	93	51 917	694 180
1985	10 901	28	47 230	8	27 490	72	532 290	92	38 391	579 520
1986	5 900	23	28 510	7	19 701	77	389 570	93	25 601	418 080
1987	9 152	38	22 200	7	14 778	62	311 520	93	23 930	333 720
1988	8 849	39	29 400	9	14 080	61	292 910	91	22 929	322 310
1989	4 642	27	25 710	10	12 847	73	237 780	90	17 489	263 490
1990	4 683	50	14 460	6	4 691	50	216 010	94	9 374	230 470
1991	2 923	30	10 460	6	6 902	70	152 100	94	9 825	162 560
1992	3 726	57	8 570	8	2 793	43	96 960	92	6 519	105 530
1993	4 084	80	15 850	12	1 042	20	119 270	88	5 126	135 120
1994	4 023	57	28 990	13	3 066	43	199 450	87	7 089	228 440
1995	9 196	63	30 140	11	5 496	37	244 130	89	14 692	274 270
1996	12 018	62	36 750	18	7 340	38	163 550	82	19 358	200 300
1997	9 270	64	37 570	22	5 214	36	133 000	78	14 484	170 570
1998	9 722	88	19 240	15	1 270	12	109 100	85	10 992	128 340
1999	13 224	86	31 700	21	2 215	14	116 040	79	15 439	147 740
2000	11 572	88	40 030	23	1 508	12	134 610	77	13 080	174 640

Source: Forschungsberichte über die Fischerei und Fischwirtschaft, BFAFi, Heft 4/2000, S. 30, ICEA (2000a) and IBSFC (baltic quota)

4. TECHNICAL AND FURTHER MEASURES

Beside the quota system technical measures are the most important tool to establish a sustainable fishery by the European Common Fishery Policy (CFP). These EU measures are completed by national measures. The most important and so restrictive one for the investigated fishermen of the Baltic Sea is the horse power limitation (221 kW). For saving quotas weekend-stops like in Denmark and Netherlands become more and more usual, but they are not binding someone. The German government tries to force self-control regulations as seen in shrimp fishery in the North Sea. There were paid subsidies in certain fisheries if the number of non-fishing days exceeds a fixed level. The days without fishing have to declare at the starting season in advance. Weekend days are not taken in account by granting the payments. There are no protected fishing areas reserved exclusively to fleet segments (LOA or gear type) as in Denmark. Engine power limitations are established for the coastal line.

Purse seine is forbidden totally in the Baltic Sea. There are uniform EU meshsize regulations by species to protect the stocks by saving the rising generations of immature, juvenile fish. Further technical conservation measures such as square mesh panels in cod-ends and exit windows aim to diminish the discards of undersized fish and the by-catch by improving the selectivity of the fishing gear are in progress. Trials have shown that square mesh panels substantially reduce not only the small sized fish, but also the volume of by-catch and so the permanent losses from the fishery and the mortality in both categories. By-catch of quoted species are limited by each target species. Single species fisheries are the most common fishery in the Baltic Sea. The fisher has to change the fishing grounds or to stop fishing if the by-catch exceeds a fixed share.

To improve the breeding and rearing condition of cod further measures as closed areas and closed seasons were extended like a protected zone for cod in the spawning area east of Bornholm and the ban on catching cod in summer enlarged by six weeks to three months.

Additionally subsidies are paid for selling vessels outside EU, decommissioning or scraping as described in the EU and national FGF programmes.

5. THE FLEET OF GERMANY AND MECKLENBURG-WESTERN POMERANIA

The structure of the German fishing fleet is extremely heterogeneous concerning to the tonnage and engine power because of the high diversity of the catch methods, target species and fishing grounds (North Atlantic, North and Baltic Sea). In total the number of fishing vessels counts about 2300 vessels (2001). The average vessel age is high and further increasing within the last years. The restricting MAPG programme and the low profitability in the last decade handicaps the modernisation and above building. Not having fulfilled the annual

objectives for the segment and equivalent capacity is withdrawn of the fleet concerned no public construction aid is obtainable.

Table 3: Fleet structure of Mecklenburg-Western Pomerania and Germany

				Length over all [m]					Age [years]									
	No	GRT	kW	< 10	10 - 15	15 - 24	>24	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 40	> 40			
MWP Bad Doberan	46	131	602	45	1	0	0	7	9	8	5	3	3	7	4			
Greifswald	26	162	673	19	7	0	0	3	4	3	3	2	1	3	7			
Nordvorpommern	135	434	1 527	122	13	0	0	23	15	19	16	6	7	16	33			
Nordwestmecklenburg	5	18	59	5	0	0	0	0	1	2	1	0	0	1	0			
Ostvorpommern	257	1 347	6 513	225	27	5	0	23	40	48	27	22	23	29	44			
Rostock	23	13 540	12 729	12	3	2	6	6	0	8	1	2	0	1	5			
Rügen	413	3 280	10 481	363	26	16	8	19	47	60	70	32	35	39	86			
Stralsund	21	94	286	16	5	0	0	0	4	1	2	3	0	2	9			
Ueckermark-Randow	76	381	1 467	74	1	1	0	5	11	16	10	6	12	8	8			
Wismar	47	376	1 164	43	1	1	2	4	3	15	6	1	4	5	8			
no assignment	53	169	1 071	51	2	0	0	2	13	18	14	4	8	8	7			
MWP total	1 102	19 933	36 572	975	86	25	16	92	147	198	155	81	93	119	211			
Bremen	10	9 348	15 016	0	0	0	10	1	2	3	2	1	0	1	0			
Hamburg	12	1 212	3 572	0	1	4	7	0	1	1	3	1	1	1	4			
Lower Saxony	184	15 461	48 900	3	24	132	25	7	9	25	30	28	37	38	10			
Schleswig-Holstein, Eastcoast	248	7 418	30 324	97	32	82	37	7	17	25	28	30	44	45	15			
Schleswig-Holstein, Westcoast	781	5 663	27 119	687	45	42	7	17	58	136	158	112	87	67	59			
Germany total	2 337	59 035	161 503	1 762	188	285	102	124	234	388	374	255	262	271	299			

Sources: BLE and eigene Berechnungen, Stand: 1997

fisheries with mainly open boats and 12 vessels are registered in mussel harvesting. 47 % of the total are located in MWP and 44 % in Schleswig-Holstein, east- and west-coast. Most of the vessels of MWP are small in size and low motorised. Nearly half in number are faced to only 23 % of the summarised engine power and 34 % in gross register tonnage (GRT). The average engine power is only 33 kW. Decreasing profit rates in the Nineties bar buildings (1-2% p.a.) and modernisations of the fleet, furthermore worsened promotion conditions and the above known uncertainty about the future development faced with both the worrying problem of depleting fish stocks and the challenge of a globalised economy are further main reasons for the serious ageing of the MWP fleet. With an average age of 25 year the vessels of MWP such as of Germany are outdated. 211 or 20% of the active fish cutter respectively boats of MWP are older than 40 years.

MWPs fleet is dominated by boats with a LOA less than 10 m. The share of this group reached nearly 90 %. Half of the owner of this group are doing fishing as additional occupation. Passive (set-net) and seasonal fishing within the three miles zone are very usual by these open boats. Next groups in size up to 15 m LOA are preferring also the regions nearby for fishing and landing as daily fishery. Both groups are extremely weather dependent not least because of their low engine power. Fisher boats with more than 15 m have their (main) occupation in fishery and are mainly self-employed and have therefore no guaranteed wage. Their income depends on the profits made by their fishing activities.

6. LANDINGS

In 2000 the total domestic and foreign landings of the German fishing fleet (high-sea and cutter and coastal fisheries) amounted to 217 400 t (catch weight, mussels and shrimps included) with a value of 190 million € and an average revenue of 0.87 €/kg. About half of the total landings are landed by the high sea fishery (115 100 t) but with only one third of the turnover. 100 900 t (high-sea and cutter/coastal fisheries) are landed in domestic ports with an average fish price of 1.01 €/kg catch weight. The cutter and coastal fisheries (< 30 m LOA) got thereof a ration of nearly 75 % of the amount and 90 % of the value (included mussel and shrimp fishing; fish landings only around 33 % of the catch and returns with 32 600 t and 34 300 Mio. €), which underlines the

Table 4: Landings and their values of the Mecklenburg –Western Pomerania fleet by species and year, coastal and cutter fisheries

	1993 - 1997				1998				1999				2000				2001			
	landings		value		landings		value		landings		value		landings		value		landings		value	
	in tons	in %	in 1000 €	in %	in tons	in %	in 1000 €	in %	in t	in %	in 1000 €	in %	in tons	in %	in 1000 €	in %	in tons	in %	in 1000 €	in %
cod	3 104	19	3 011	30	3 039	20	4 376	38	4 041	27	5 617	46	3 471	24	5 762	43	3 338	20	5 659	37
herring	9 528	57	2 001	20	7 309	48	1 608	14	7 013	47	1 543	13	6 477	45	1 439	11	8 628	53	2 136	14
flounder	1 787	11	1 036	10	1 995	13	1 244	11	1 883	13	942	8	1 995	14	1 244	9	1 591	10	1 055	7
SUM cod, herring, flounder	14 419	86	6 048	61	12 343	81	7 228	62	12 937	86	8 101	67	11 943	83	8 445	64	13 557	83	8 850	57
cod	105	1	100	1	25	0	46	0	237	2	673	6	343	2	1 125	8	435	3	2 808	18
eel	298	2	1 091	11	238	2	893	8	241	2	892	7	272	2	971	7	254	2	975	6
pike-perch	129	1	1 049	11	135	1	1 180	10	124	1	977	8	108	1	940	7	108	1	979	6
others	993	6	536	5	794	5	691	6	912	6	538	4	909	6	575	4	1 085	7	575	4
perch	595	4	863	9	595	4	857	7	454	3	745	6	281	2	472	4	329	2	620	4
pike	121	1	197	2	98	1	172	1	104	1	184	2	122	1	208	2	117	1	200	1
salmon/trout	13	0	57	1	15	0	59	1	10	0	67	1	27	0	103	1	20	0	76	0
sprout	59	0	16	0	587	4	59	1												
saithe					449	3	445	4					432	3	450	3	390	2	418	3
SUM others	2 313	14	3 908	39	2 936	19	4 400	38	2 082	14	4 076	33	2 494	17	4 844	36	2 738	17	6 651	43
SUM total	16 732	100	9 956	100	15 279	100	11 628	100	15 019	100	12 177	100	14 437	100	13 289	100	16 295	100	15 501	100

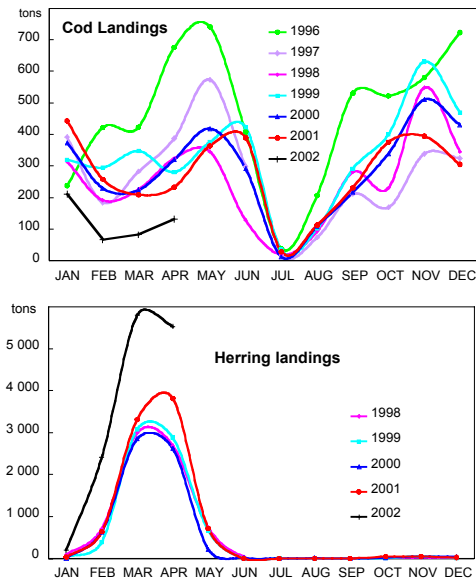
Source: Annual reports on agriculture of Mecklenburg- Western Pomerania 1999-2002

regional relevance of the small scale fishery.

In 2000 the rate of MWP cutter and coastal fishing fleet amounted about 6 % of German landings at all and about 15 % of the landings and 10 % of the turnover of the total German cutter and coastal fishing fleet (mussels and shrimps included).

The MWP landings are dominated by only three species (Baltic) cod, herring and flounder. Their shares totalled from 80 to 90% of the landings and two thirds of the proceeds within the past years. On quantity herring is unchallenged the most important fish (45 %), followed by cod (30 %) and flounder (15 %). On value cod delivered nearly 50 % in 2000, herring such as flounder around 10 %.

Figure 1: Monthly landings of cod and herring Mecklenburg-Western Pomerania, 1996 – 2002



Source: BLE, Monthly Reports on German Fishery, 1996-2002

the 12 miles zone so that the steaming time to the grounds in most cases was less than one hour. Overnight one-day-fishing five days a week was the usual method of this manner of fishing.

Figures 1 shows the monthly cod and herring landings of Mecklenburg-Western Pomerania. According to cod the main landing season is the first half of the year and the autumn. The low catch in summer is caused by a ban on catching cod in summer. As mentioned before the IBSFC prolonged the closed season on cod to three months and the protected area for cod was maintained in the cod spawning area east of Bornholm due to the depleting Central and Eastern Baltic cod stock. Target species Baltic cod fisheries are done usually from one day (< 20 m LOA) to less than one week (> 20 metres LOA) on average.

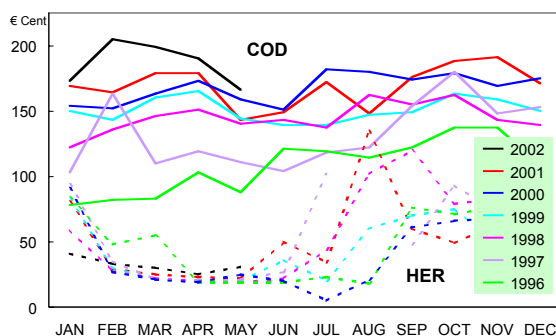
The season of herring fishery is limited strongly to the spawning season in spring beginning in early February to mid of April. By then the density of the herring stocks is high enough for successful and economical harvesting at the coastal line. The main part of two thirds is caught by small scale particular passive fishery (set-net) with boats less than 15 m LOA. Last years most landings are bought locally to a few fish processors or for direct human consumption. In 2001 and 2002 considerable herring amounts are landed outside mainly to Denmark because of better fish prices due to depleting cod stocks in the North Sea and the Central Baltic Sea (see Table 1: shortage of herring TAC by 33 %). The rest of one third has been caught by bottom cutter and trawler mostly between 15 and 30 m LOA. Regarding this group the low powered small scale boats preferred pair-trawling, the stronger motorised are doing also in single trawling both within

7. PRICES

The prices situation of the producer becomes continuously better within the last six years. Relative high demand by industry forced by relative low landings (TACs) in Europe and Germany results in an low self-supply and in year by year increasing prices for most fish species. The total catches of the cutter fisheries decreased 2000 against 1999 by almost 8 %, while the turnover could be increased by 2 %. Average revenues per kg catch weight thus rose by 10 % from 1.12 to 1.24 €/kg.

The prices of Baltic cutter target species cod, flounder, herring are tired up slightly (cod) or been more or less at a constant level (herring and flounder) since 1996 as figure 2 shows.

Figure 2: Cod and herring prices, 1996-2002



Source: BLE, Monthly reports on fishery

Concerning to a low rate of self-sufficiency, further increasing fish consumption per capita in Germany and a constant world fish catch increasing producer prices are to be expected on the long run. 13.3 kg (catch weight) fish per capita or 252 400 t on total are landed (Imports included). The total domestic human consumption per capita slightly amounted to 7.4 kg in 2000; one third of the processed fish was exported to foreign countries which underlines the importance of the German fish processing industry. Within the previous years only a small – year by year slightly decreasing – share in time of 10% (25 700 t) was supplied by direct landings (in domestic ports) of the German fishing fleet.

8. COSTS AND EARNINGS

Due to the FAIR Project CT-96-1454 the cost and earnings of a specific fleet segment of MWP were calculated in 1996. For this paper the same pretty homogeneous sample of Baltic Sea vessels (n=7) were analysed again for data of 2000. The basis for the calculations were the bookkeeping data. In 2000 their landings decreased by around 22%. Disproportionately higher fish prices compensated the losses of the fish amount, so that the total returns went up 45%. Accordingly the gross profit doubled (+122%).

Table 5: Costs and earnings 1996 against 2000

	1996			2000			2000 to 1996	
	€	... relative % to returns	costs	€	... relative % to returns	costs	€	%
crew wages	75 482	28	37	116 837	30	42	+ 41 355	+ 55
social insurance	16 832	6	8	19 262	5	7	+ 2 430	+ 14
sum labour costs	92 313	35	46	136 099	35	48	+ 43 786	+ 47
provision	4 201	2	2	4 619	1	2	+ 418	+ 10
crew travelling	390	0	0	0	0	0	- 390	-100
marketing & auction	52 700	20	26	37 583	10	13	- 15 117	- 29
fuel & lubrication	21 084	8	10	40 753	11	15	+ 19 669	+ 93
maintenance & repairs	16 721	6	8	29 001	8	10	+ 12 280	+ 73
net & gears	7 705	3	4	10 280	3	4	+ 2 575	+ 33
ice	3 423	1	2	3 480	1	1	+ 57	+ 2
insurance	5 664	2	3	5 836	2	2	+ 172	+ 3
others	14 065	5	7	13 100	3	5	- 965	- 7
sum costs	218 266	82	100	280 751	73	100	+ 62 485	+ 29
sum returns	265 458	100		385 627	100		+ 120 169	+ 45
gross profit	47 192	18		104 876	27		+ 57 684	+ 122
total landings in kg	299 953			233 572			- 66 381	- 22

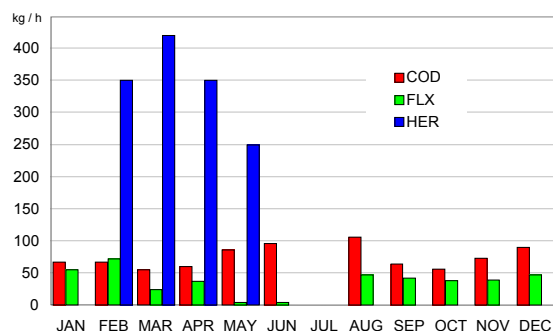
Source: Individual bookkeeping data, 1996 and 2000, own calculations

very high profitability in 2000 of the fleet segment concerned it is remarked that the cost items of depreciation and interest of the total invested capital is not taken in account in this case. For the investigated vessels these costs claim nearly a quarter of the proceeds (basis replacement value vessel). The method of calculating the crew wage differs in a wide range between enterprises. Mostly it's based on the proceeds directly. Sometimes landing, auction & marketing and fuel costs are subtracted in advance or a ground wages plus a share of the proceeds is paid. For model purpose only the variable costs are included, because in the short run the fix costs had no influence on the owners decision for going for fishing or staying in the harbour. They are deciding more or less in variable cost terms. For (variable) cost allocation and deriving the cost and production function see next chapter.

9. Model design

The model is already described in detail in the final report of the FAIR project and at the IIFET 1998. Therefore the description in this paper is limited on some words. The applied model is a mixed integer model (MIP) with the objective of maximising the gross profit (gross margin). The programming language is GAMS (General Algebraic Modeling System, Release 2.50, Distribution 20.0). For solving the MIP the CPLEX solver of GAMS Development Corp. is used. We preferred a deterministic model design. Feasibility tests were made to calibrate different parameters of the model by comparing the empirical results with practice (bookkeeping and catch records of the logbook of the sample vessels, expert knowledge of the PO managing director).

Figure 3: Model catch rates (kg/h at fishing ground)



Source: catch records, pers. communications

The production function is estimated mainly as function of the fishing effort in terms of the catch rate (kg/h at fishing ground, see figure 3) depending on fishing area, month, technical equipment as gear etc. and target species caught, the monthly prices of the different fish species (see figure 4) caught and time at sea depending on fishing area, landed port (steaming time).

The cost function is estimated using costs and earnings derived by bookkeeping data as described above. Simulating the fishermen's short run behaviour only such costs are considered that directly caused by the operational fishing. Some of these costs are fix costs some are variable in the bookkeeping. So depreciation (fix) costs partly have variable cost character in this model purpose (engine, ice makers, echo sounders etc.), just as maintenance and repairs. These items have a fix and variable cost share. In such cases 25- 50% of the tax based fix costs are defined as variable (operational induced) costs. In this sense the model defined variable costs are those costs that in one way or another vary with the level of activity of the vessel. In the next step the different cost items allotted to the activities. The costs are referenced to time based units like the steaming, effort and harbour time (fuel and lubrication costs, parts of maintenance of the hull and engine, provisions), to value based units like the proceeds (landing and auction costs, crew wages), to quantity based units like the landings (ice and conservation costs), to trip based units like the travelling costs. There are implemented additionally different load factors for the engine (steaming time set to 1) as weighting coefficients.

There are lots of constraints implemented within the model. Some of them are CFP induced measures as output measures (TAC and quotas), input measures (vessel capacity, effort limitations as available days) and technical measures (mesh size). The most restricting one in practise as in the simulation model is surely the quota and time as available days per year respectively month. The base input parameter unit for optimising is one hour (time-based variables), kilogram (volume-based variables), days (trip, time-based), and € Cent (value-based variables). Some of the constraints are of physical nature as loading capacity, available days per month and year (holidays, bad weather etc.) and maximum seadays (fuel).

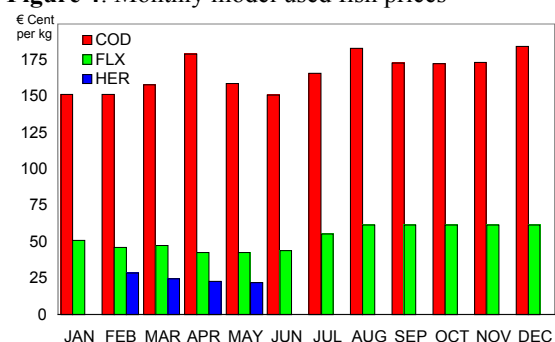
10. RESULTS

Before we are going to ask for the profitability of herring catch against cod we want to have a look at the base line solution checking the received model results to practice. Next step we are interested in is estimating the effect of further cod quota cuts on income (gross profit). At least impacts of different other scenarios are simulated like catch effort reduction and price effects on cod and herring and the competitiveness against herring and cod.

Lots of indicators can be printed out in GAMS in form of a report such as: total landings and landings by species and months; returns by species and months so as total returns, different cost items, gross profit, fishing activity items like days at sea and number of trips on monthly basis. Only some of them will be listed and discussed in the following chapters. There are also some indicator of the solution procedure of GAMS and CPLEX, respectively.

10.1. Base line solution

Figure 4: Monthly model used fish prices



Source: BLE, Monthly reports on fishery

results of the basic (model) run differ slightly (see table 6) against the „practice“. Returns and variable costs of the sample compared with the optimised simulation output are about 4–9 % higher. The optimising procedure rules – as expected because of the deterministic model formulation - to a 6% better income (gross profit). A few more seadays (+4%) and trips (+14%) are recorded by

For purpose of evaluation of the model conception and calibration the model is run using the bookkeeping data and the above known sources as reference system. The

Table 6: Baseline simulation solution against bookkeeping of the sample

base line solution COD quoted (base = 2001)	base line model	sample average results (PO)	differenz	share
proceeds in €	380 657	394 717	+ 4%	
variable costs in €	232 124	254 623	+ 9%	
gross profit in €	148 533	140 094	- 6%	
gross profit / proceeds	39%	35%	- 10%	
fishing activities				
No. of trips	30	35	+ 14%	
seadays	164	171	+ 4%	
landings in kg				
COD	210 948	not available	-	62%
FLX	109 967	not available	-	32%
HER	6 600	not available	-	2%
others	11 093	not available	-	3%
total	338 608	not available	-	100%
proceeds in €				
COD	300 334	not available	-	80%
FLX	60 335	not available	-	16%
HER	2 988	not available	-	1%
others	12 057	not available	-	3%
total	375 714	not available	-	100%
COD quota in kg	212 000	212 000	-	
utilisation	100%	-	-	

Sources: own calculations, bookkeeping data and personal communications

the sample fisher. The share of the landings and returns by species was not available for these regional bottom trawler fleet segment (sample), but the simulation data are approximately in accordance to official statistics of the landings of the small scale vessels of MWP (BLE, 2001).

The assumptions of this base line simulation are a combined cod and flounder fishery as target species, herring as by-catch only. Cod are quoted vessel based at the level of 2001 (212 t). For the assumption of the fish prices and catch rate see figure 3 and 4 of the previous chapter.

10.2. Impacts of further cod quota cuttings

As seen in table 1 the cod TAC and quota are once more sharply cut by about 30% in 2002 compared to 2001. That is more than 50% in relation to 1996. The prices of cod themselves remained relative stable at the level of 2001 (only statistics included May 2002 are available, see figure 2). Increasing shares of small sized fishes are a sure indicator of the worsening condition of the cod biomass and stock situation. This analysis is supported by behaviour chances of the Baltic fishery. In 2001 the main fishing grounds have been as the two years before the fishing grounds around Fehmarn and nearby Kiel (Bay of Mecklenburg and Kiel). The traditional areas (before

Table 7: COD quota cuts without herring fishing activity

COD quota cuts no HER fishing	Base line (model) COD quota 2001		COD quota ...					
	absolut	relativ	- 5%	- 10%	- 15%	- 20%	- 25%	- 30%
proceeds in €	380 657	100%	96%	90%	86%	85%	80%	75%
variable costs in €	232 124	100%	96%	91%	87%	85%	81%	75%
gross profit in €	148 533	100%	96%	90%	83%	83%	78%	75%
gross profit / proceeds		39%	39%	39%	38%	39%	38%	39%
activities								
trips	30	100%	90%	97%	107%	100%	103%	83%
seadays	164	100%	94%	93%	96%	90%	90%	77%
landings in kg								
COD	210 948	100%	95%	89%	83%	79%	75%	70%
FLX	109 967	100%	100%	95%	98%	100%	93%	88%
HER	6 600	100%	117%	112%	90%	116%	117%	101%
others	11 093	100%	93%	87%	64%	72%	63%	63%
total	338 608	100%	97%	92%	87%	87%	81%	76%
proceeds in €								
COD	300 334	100%	96%	90%	84%	81%	77%	72%
FLX	60 335	100%	100%	95%	98%	99%	93%	89%
HER	2 988	100%	107%	105%	93%	107%	107%	96%
others	17 000	100%	135%	125%	107%	122%	110%	108%
total	380 657	100%	98%	92%	87%	86%	81%	76%
COD quota	212 000	100%	201 400	190 800	180 200	169 600	159 000	148 400
COD quota utilization	100%	100%	100%	99%	97%	99%	100%	100%

Source: own calculations

proportional to the proceeds resulting in 5% higher gross profit level than the quota reduction. The fishing effort (seadays) could/must be reduced by 23 % or 164 to 124 days because of the missing fish resource cod. The number of trips reach the 83% level bit higher than the 70% quota reduction. As expected the cod quota is fished out totally at all quota cut levels. Maximising gross profit the fishing activities within the year are laid in these periods where the catch rates of the non quoted flounder are relatively high for saving the quota of cod. Therefore the days at sea and the number of trips don't decrease continuously like the quota cuts. There are surely model and reality dependent some limits because the Baltic fishery of the observed vessels are in some areas and time periods a combined fishery of cod and flounder. Nevertheless the continuously increasing of the flounder landings within the last years are confirming the correctness of the model results. A cod quota cut of 25% leads in nearly constant flounder landings (93%). Therefore the total landings decline till the 25% quota reduction with a lag and reached anyhow 81% of the initial simulation. The composition of the total landings changes encouraging the flounder.

10.3 Landings and economics of Herring fishing under cod quota conditions 2001

The main intention of this study was to investigate the profitability of herring fishing of the sample of the 26.5 m vessels. The cod quota is set constant to the 2001 level. All other fish species are not quoted. As before the results will be discussed against the baseline solution which represents the „traditional“ fishing behaviour. In 2001 a few fisher already did purposeful herring fishing. These few outcomes - surely in some cases shaky - are used as inputs (model parameter) to estimate the impacts on the behaviour and economics. The most crucial

Table 8: Cod quoted and targeting herring fishery

COD quota 2001 HER fishery	base line model solution		base line plus HER fishery			
	absolute	relative	absolute	dif. absolute		
				absolute	relative	relative
proceeds in €	380 657	100%	420 454	+ 39 797	110%	
variable costs in €	232 124	100%	264 149	+ 32 025	114%	
gross profit in €	148 533	100%	156 304	+ 7 771	105%	
gross profit / proceeds		39%			37%	
activities						
trips	30	100%	39	+ 9	130%	
seadays	164	100%	199	+ 35	123%	
landings in kg						share
COD	210 948	100%	207 948	- 3 000	99%	36%
FLX	109 967	100%	96 652	- 13 315	88%	17%
HER	6 600	100%	261 251	+ 254 651	3958%	45%
others	11 093	100%	12 863	+ 1 770	116%	2%
total	338 608	100%	578 714	+ 240 106	171%	100%
proceeds in €						
COD	300 334	100%	292 563	- 7 771	97%	70%
FLX	60 335	100%	55 046	- 5 289	91%	13%
HER	2 988	100%	54 975	+ 51 987	1840%	13%
others	17 000	100%	17 870	+ 870	105%	4%
total	380 657	100%	420 454	+ 39 797	110%	100%
COD quota	212 000	100%	212 000	212 000	212 000	
COD quota utilisation	100%	100%	207 948	- 3 000	98%	

Source: own calculations

14% higher variable costs. All available „herring“ months in spring (February till May) are used for herring and in small extend for cod. The total amount of herring (261 t) outreached the cod catch (207 t). The herring catch seems to be attractive, but not for extensively saving the cod quota. The total amount of herring (261 t) outreached the cod catch (207 t). The herring catch seems to be attractive, but not for extensively saving the cod quota. Only 2% of the cod quota are kept unused. On the other hand seems to be the available days sufficient to reach the 98% cod quota level and to catch additionally herring in relevant amounts. Free access for cod may result in stopping herring catch as seen later. 45% of the total amount are herring 36% are cod faced to 13% and 70% of the proceeds contrasted with 2% and 62% (herring and cod catch) respectively less than 1% and 79% (herring and cod proceeds). Nevertheless this additional income has to be paid by a high additional physical input as seadays (+35 or 23%) and additional trips (+9 or 30%). So the available days become besides the cod quota the next limiting factor.

10.4. Competitiveness against herring and cod

In future further shortages of the cod quota are expected. As seen before the additional share on income of herring fishery is pretty small. Therefore also small herring income effects are expected under further cuts of the higher profitable cod quota. The impacts of a 5% step cut till 30% are shown in detail in table 10 (annex). Cod cut of more than 10% cannot be compensated by herring catch. At a 10% lowered cod quota the proceeds can be increased to 105% with herring fishing (compared to non herring fishing) but the variable costs disproportionately increase to the 109% level resulting in a 98% gross profit. An 30% cod quota reduction leads in a 80% level of income (gross profit).

Table 9: Competitiveness against cod and herring (herring and cod not quoted)

COD not quoted with (spring-) HERfish catch	Modell base line no HER fishing		base line (c.p.) with HER fishing		base line (c.p.) plus HER catch allowed, COD free access (not quoted) catch rates of HERfish ...						
	absolute	relative	absolute	relative	+ 20 %	+ 25 %	+ 30 %	+ 50 %	+ 80 %	+ 100 %	+ 150 %
proceeds in €	380 657	100%	435 124	114%	114%	114%	118%	121%	122%	123%	134%
variable costs in €	232 124	100%	267 993	115%	115%	115%	119%	122%	123%	124%	135%
gross profit in €	148 533	100%	167 131	113%	113%	113%	116%	119%	120%	122%	134%
gross profit / proceeds		39 %		38%	38%	38%	38%	39%	39%	39%	39%
activities											
trips	30	100%	40	133%	133%	133%	133%	133%	137%	137%	133%
seadays	164	100%	201	123%	124%	124%	125%	125%	125%	125%	124%
landings in kg											
COD	210 948	100%	249 389	118%	118%	118%	115%	113%	108%	107%	96%
FLX	109 967	100%	115 562	105%	105%	105%	103%	103%	96%	96%	85%
HER	6 600	100%	6 492	98%	98%	102%	1696%	2843%	4622%	5262%	11264%
others	11 093	100%	13 253	119%	119%	119%	122%	124%	119%	116%	110%
total	338 608	100%	384 696	114%	114%	114%	142%	163%	193%	204%	311%
proceeds in €											
COD	78 513	100%	350 220	117%	117%	117%	114%	112%	107%	106%	95%
FLX	60 335	100%	62 995	104%	104%	104%	104%	103%	98%	97%	89%
HER	2 988	100%	3 406	114%	114%	119%	838%	1366%	2183%	2490%	5224%
others	238 821	100%	18 504	109%	109%	109%	112%	114%	109%	105%	99%
total	380 657	100%	435 124	114%	114%	114%	118%	121%	122%	123%	134%
COD quota	212 000	100%	free	free	free	free	free	free	free	free	free
utilisation to base line	100%	100%	249 389	118%	118%	118%	114%	113%	108%	107%	83%

Source: own calculations

inputs are the assumed catch rate as amount fish caught at the fishing grounds per hour and the accompanying prices. The model used cod and flounder catch rate based on the analysis of the catch records of the logbooks and estimations of the members of a PO of these investigated vessels and their managing director. For future years they are expecting progress in herring fishing efficiency in terms of higher catch per hour. Fish prices are gathered from official regional statistics and expert knowledge of the PO (figure 3). The assumed catch rates in spring (February to May) differ between 250 and 420 kg/h compared with 55 up to 105 kg/h for cod and flounder up to 72 kg/h (see figure 4).

This simulation shows that the gross profit can be enriched by 5% or 7 500 € if fishermen act in targeting herring fishing. 10% higher returns are faced to

Next to see was at which level (catch rate or herring price level) herring fishing becomes more attractive saving cod quotas. The effect on income of increasing catch rates are very similar to increasing fish prices so here are presented only the results simulating better catch rates. Only

of herring fishery

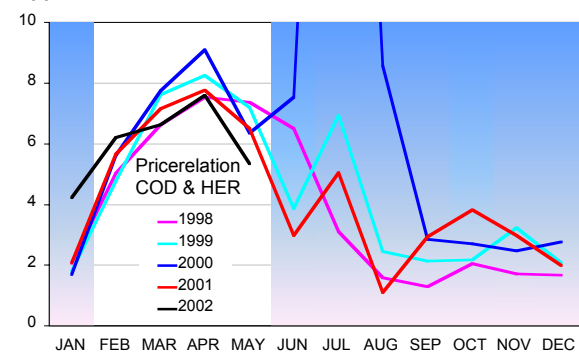
under unusual high catch per hour the vessel size is a restricting factor. Different herring catch rate levels (0, +20, +25, +30, +50, +80, +100, +150%) based on the base line run are calculated. Free access (no quota) was the assumption for cod. Under such conditions the profitability is as expected much better than under the restricting cod quota conditions. The most restricting factor are the model available days per month and year. They are fully and exclusively used for cod fishing. The herring fishing activities are set to zero. The amount of landed cod are 18% (48 t) higher as the gross profit reaches a 113% level. Higher proceeds (+14%) but also higher costs (+15%) contribute to these income effects. The therefore necessary seadays are quite close to the upper limit (absolute 201 days or +23%) the model constraint allows.

Next question was at which herring catch rate level this activity is more profitable. The starting catch rate level +25% has no effect on the behaviour and economical situation of the investigated fleet segment. Cod fishing is not reduced, no herring fishery take place, herring seems to be not competitive. At +30% herring catch rate level this fishery is taken up. Small amounts of herring are caught in one month (March), the month with the highest catch per hour (see figure 4). Raising the catch rate stepwise results in additional catches in April (+40% catch rate), in February (+60%), and finally in May (+100%). In the same manner cod fishing is cut down. Nevertheless even if the herring catch rate is doubled (+100%) the cod landings are with 107% higher than the actual cod quota (assumption of the base line solution = 100%). When the herring catch rates reach the 125% level cod are directly substituted by herring. At 150% level the cod landings lowered to 96% of the base line level and the quota utilisation compared to the base line is 83%. The economical indicator gross profit as well the proceeds raises to 134%. The available seadays (201) are fully used.

11. ACTUAL SITUATION

The actual situation in 2002 is that the German Baltic cod quota was shortened by about 30%. The corresponding cod prices until May surpassed the previous year prices by 6 – 25%, as the herring prices got up between 8 (April) and 40% (May). The price relation between herring and cod seems to be relative stable last years (see

Figure 5: Relation of cod and herring prices, 1998-2002



Source: BLE, monthly reports

figure 5). Nevertheless the herring landings reached a quantity not seen since 1990. In the current year the herring quota of MWP (Baltic Sea) is fished out to 63 % (see table 1). As fishermen reported they are intending to check herring fishing also in fall and perhaps to reactivate spratt fishing next spring. Hopefully the starting up of the herring processing plant will stabilise the prices and reduce the marketing costs by direct landing at the plant and last not least the biological source will remain stable.

Under these new conditions (increasing prices, cut of the cod quota and the expansion of the protected season for cod) the profitability of herring fishing could be underestimated. Nevertheless globefish reports in this august about a high supply of herring. There should be mentioned that the herring market is a global market and

so deeply dependent from the supply and demand of herring anywhere. The Atlantic and North Sea herring seems to recover faster than expected and the prices seems to go down in time. There is also uncertainty about the future development of the Baltic herring stocks. As seen in table 1 the German herring quota in 2002 was cut by 30 %. The utilisation of the German (Baltic) herring quota has passed the 63% mark.

12. CONCLUSIONS

Nevertheless this model seems to be a suitable tool for estimating different exogenous effects. As the model and the actual Baltic Sea fishery behaviour shows herring fishing could improve and stabilize the income situation concerning the restrictive cod quota conditions. But the particularly low additional income (+5%) requires a considerable input on time in form of trips and seadays. For saving cod quota the efficiency in terms of increased catch rates has to be improved by more than 100% or in the same extent higher herring prices has to be achieved. Model based sensitivity analysis shows that the risk to run at a loss is quite small. The new-built herring processing plant ensures the sales at low transportation and marketing costs.

13. REFERENCES

