



Whitefish (*Coregonus lavaretus* (L.)) landings in the Baltic Sea during the past 100 years: combining official datasets and grey literature

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with 4 figures and 1 table

Abstract: European whitefish (*Coregonus lavaretus* (L.)) has been one of the commercially most important Baltic Sea freshwater fish species, especially in northern regions. More or less systematic recording of whitefish landings in the Baltic Sea started nearly a century ago. Although understanding the development of local fisheries is crucial for the sustainable management of fish populations, to date there are no combined data (including both commercial and recreational fisheries) available which summarise past whitefish landings in the Baltic Sea area. In this study we summarised available data on whitefish landings using official datasets and also the so-called grey literature, i.e. different reports and journals of fishing societies. This revealed that increasing fishing effort and modernisation of fishing gear in all Baltic Sea regions resulted in increased landings during the first half of the twentieth century, but an overall decline in whitefish catches has been evident from the mid-1950s and was probably caused by overfishing, eutrophication and restricted access to spawning grounds.

Keywords: Catch statistics, Baltic Sea, landings, historical data.

Introduction

The Baltic Sea is one of the world's largest brackish water bodies. However, the diversity of its ichthyofauna is relatively poor because such brackish water is a poor habitat for both freshwater and marine species. However, several fish species with relatively wide salinity tolerances are abundant and constitute stocks with considerable commercial value (Ojaveer et al. 1981). The bulk of Baltic Sea fish landings consists of species of marine origin (e.g. Atlantic herring (*Clupea harengus* L.), Atlantic cod (*Gadus morhua* L.), European sprat (*Sprattus sprattus* L.) while freshwater and migratory fishes are important in catches of local coastal fisheries. The latter stocks may be particularly vulnerable to fishing pressure and changing

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environments (Hildén et al. 1982, Regier et al. 1988, Ojaveer 1999, HELCOM 2006). During the twentieth century, both natural and anthropogenic factors have caused significant changes in the Baltic Sea ecosystem. Influences of human origin, e.g. intensive fishery, damming of spawning rivers, pollution and eutrophication, have caused the most visible effects by diminishing the populations of migratory fishes including salmonids and coregonids (Regier et al. 1988). Among those species is European whitefish (*Coregonus lavaretus* (L.)), which is one of the most valuable and important target species of local fisheries, particularly in the northern regions of the Baltic Sea (Lehtonen 1981, Lehtonen & Böhling 1988, Huhmarniemi & Salmi 1999, Aronsuu & Huhmarniemi 2004, Uusitalo et al. 2005).

Whitefish colonised the Baltic Ice Lake shortly after the beginning of the deglaciation more than 10,000 years ago (Svårdson 1979, Østbye et al. 2005). The first historical evidence of Baltic Sea whitefish fisheries comes from the Stone Age, for which archaeological remains of whitefish are known from numerous neolithic settlements along the coast (Kriiska et al. 1998, Veski et al. 2005, Olson 2008). In medieval times, Olaus Magnus recorded the importance of whitefish (*sijck*) in the food of local natives living in Swedish and Finnish shores of the Baltic Sea (Magnus 1555). Historic Russian documents from the late fifteenth to the nineteenth centuries indicate that whitefish was of importance to local fisheries in the eastern part of the Gulf of Finland and was often used for taxation purposes (Kraikovski et al. 2008).

Being an easily exploitable and valued object for fishermen, some whitefish stocks showed signs of decline more than a century ago. Decreases of whitefish stocks, presumably caused by excessively intensive fisheries on spawning grounds, were observed in the Curonian Lagoon during the second half of the nineteenth century (Benecke 1881). Catch data from some Swedish counties indicate that close to the end of the nineteenth century, fishing effort for whitefish increased several-fold and overfishing could have led to a decrease in yields at the turn of the century (Ojaveer et al. 2007).

More systematic collecting of Baltic Sea fish landings data started during the first decades of the twentieth century, but the complicated history of the region in the last century has caused much fragmentation and dispersal of recorded information (MacKenzie et al. 2007). A considerable part of this information is available from local fisheries bulletins or archives, although such so-called grey literature is usually absent from the general and easily accessible body of knowledge about fish stocks. The main goal of the present overview is to summarise available information concerning Baltic Sea whitefish landings during the last 100 years and to discuss observed trends in the catch dynamics in different areas.

The Baltic Sea is inhabited by two sympatric whitefish forms, the sea-spawning *C. lavaretus widegreni* Malmgren, and the anadromous *C. lavaretus* L. s.str. (Himberg 1970, Svårdson 1970, Svårdson 1979, Lehtonen & Himberg 1992). Although usually these forms are easily separable by gillraker counts, they are not separated in catch statistics. However, these forms may contribute differently to local fisheries as the differences in their ecologies (i.e. different spawning grounds, migration patterns) may render the development of these populations to be differently influenced by various factors (e.g. spawning ground accessibility and destruction, intensity of fishery). Thus, one of the aims of this study is also to summarise available data on the catch dynamics of these different whitefish forms.

Materials and methods

The most complete information on European whitefish landings from the Baltic Sea during the last 100 years is available in the Eurostat/ICES database on catch statistics using the programme FISHSTAT Plus (FAO 2011, ICES 2011). Finnish and Swedish whitefish landings are available since 1910. For the rest of the Baltic Sea countries, Eurostat/ICES datasets are more fragmentary mainly because of turbulent historical events during the twentieth century, when wars, occupations and frequent relocations of archives often led to the destruction of written records or prevented the collection of data. In the Eurostat/ICES datasets from the 1920s and 1930s, whitefish landings are frequently summarised together with Atlantic salmon (*Salmo salar* L.) and sea trout (*Salmo trutta* L.) catches under the term 'salmonids' and are therefore unusable for the present purposes. Additionally, we found Eurostat/ICES data relating to Soviet Union Northeast Atlantic region (i.e. Baltic Sea) whitefish landings from 1950 to 1987 to be obviously erroneous because they involved drastic fluctuations from a few tens of tons to a few thousands of tons during short periods.

It should also be taken into account that data from several areas during some periods may be partly missing and therefore total annual landings might be underestimated in the databases (Ojaveer et al. 2007). Considering this, the highest presented values of annual landings were always used for further analysis except for cases where a higher value was clearly caused by the rounding off of data. Therefore, more detailed original data from Swedish statistical yearbooks were used for the Swedish dataset from 1950 to 1973. The Finnish dataset from 1965 to 1973 was reconstructed similarly using landings data given by Lehtonen (1981).

In conclusion, we formed the foundation of a combined dataset based on countries' official whitefish landings data as presented in the Eurostat/ICES publicly available catch data by area and year. Additionally, official national datasets were used when available (Lehtonen 1981, Awebro & Poulsen 2011). The grey literature part of the combined dataset is derived from various sources including reports, local fisheries bulletins and data from local archives and scientists (Table 1).

Sweden

The Swedish Eurostat/ICES dataset has a gap for 1913 to 1914 and data for 1932 to 1949 are summarised as salmonids. Whitefish landings from 1911 to 1931 are marked as 'Coregonus/Whitefish nei' (not elsewhere included). It is presumed that those landings data contain also vendace (*Coregonus albula* (L.)) and so these data cannot be used in this analysis. Recovered historical data for whitefish landings between 1913 and 1950 are available from the Baltic Sea subcomponent of the History of Marine Animal Populations Project (HMAP) database (Awebro & Poulsen 2011). Swedish official landings data for 1914 to 1980 from Swedish statistical yearbooks were kindly provided by Sture Hansson of Stockholm University. Swedish Eurostat/ICES data include only commercial landings, although recently reconstructed whitefish catch data with added recreational, illegal, unregulated and unreported landings and discards estimated by Persson (2009) are also included in our dataset (Table 1, Fig. 2).

Finland

Eurostat/ICES Finnish landings data from 1932 to 1949 cannot be used in this analysis because whitefish and salmonid species are summarised together. For the period from 1950 to 1974, whitefish catches are rounded to the nearest 100 t, although unrounded data for the time period from 1962 to 1979 are presented by Lehtonen (1981). Recreational catch is included in whitefish landings data since 1953 (Rossing et al. 2010).

Year	Country																										
	Finland			Sweden			Russia				Estonia		Latvia		Lithuania			Poland			Germany						
	1	2	3	1	4	5	6	3	13	9	1	14	3	1	7	1	8	3	1	9	1	10	11	1	12	11	
1941				434	205																						
1942				509	225																						
1943				482	234																						
1944				614	66																						
1945				627	274									29													
1946				612	100									29													
1947				608	108									27													
1948				553	269									22													
1949				712	631									64													
1950	1800			700	691	356	1080							170													
1951	1400			900	857	491	1315							187													
1952	500			700	697	489	1180							272													
1953	2000			800	768	426	1308							207						4							
1954	1500			700	669	198	1243							210						8							
1955	1400			600	635	165	1253							139						21							
1956	1400			600	586	300	1246							73						15							
1957	1500			700	678	494	1401							123						6							
1958	1400			500	667	323	1438							107						5							
1959	1400			500	657	173	1477							91						5							
1960	1500			500	672	208	1543							123						8							
1961	1500			500	659	210	1579							173						9							
1962	1400	1778		400	591		1553							115						12							
1963	1400	1283		600	564		1576							86						5							
1964	1100	1312		500	490		1544							69						5							
1965	1200	1192		400	429		1533							60						2							
1966	1300	1314		400	419	132	1579							79						2							
1967	1100	1148		400	390	222	1603							72						1							
1968	1700	1699		400	373		1639							79						5							
1969	1700	1641		400	414		1747							41						3							
1970	1200	1150		400	380		1602							56						4							
1971	1700	1683		400	398		1632							44						1							
1972	2000	1988		400	438		1749							61						2							
1973	2000	1986		500	483		1859							52						0							
1974	2100	2100		510	510		1972							69						3							
1975	2019	1922		554	554		2243							48						2							
1976	2036	2036		502	503		2161							26						3							

Year	Country																									
	Finland			Sweden			Russia			Estonia		Latvia		Lithuania		Poland		Germany								
	1	2	3	1	4	5	6	3	13	1	14	3	1	7	1	8	3	1	9	1	10	11	1	12	11	
1977	1967	1967		301	476			1903																		
1978	1487	1477		402	400			1988																		
1979	1996	1994		418	416			1974																		
1980	2016			508	506			2044																		
1981	2145			315				1794																		
1982	2038			375				1837																		
1983	1961			323				1744																		
1984	1898			338				1733																		
1985	1801			316				1676																		
1986	2091			367				1715																		
1987	2367			433				1778																		
1988	2612			440				1763																		
1989	2510			466				1778																		
1990	3309			1312	367			1608	346																	
1991	3542			1545	335			1589	315																	
1992	2880			1304	307			1570	290																	
1993	2783			1207	354			1663	337																	
1994	2083			1104	571			2022	557																	
1995	2140			1161	465			1761	277																	
1996	2084			1280	350			1484	192																	
1997	1961			1157	307			1322	151																	
1998	2351			1425	305			1213	127																	
1999	2172			1246	279			1073	93																	
2000	2120			248				1014	72																	
2001	1826			154				849																		
2002	1206			222				920																		
2003	1200			255				925																		
2004	1181			295				935																		
2005	1122			247				819																		
2006	1490			198				683																		
2007	1458			153				619																		
2008	1469			143																						
2009	1313																									

Russian Federation

Information about Russian whitefish catches is fragmentary. For the eastern part of the Gulf of Finland, landings statistics are available for the periods 1937 to 1940 and 1949 to 1971 (Smirnov 1972). Five-year average landings data (1946 to 2005) for the Gulf of Finland are presented by Kudersky et al. (2008). Data on whitefish catches from the Curonian Lagoon for 1952 to 2000 were kindly provided by Rimantas *Repečka* of Vilnius University. Data on whitefish landings from the Curonian Lagoon from 1914 to 1931 are included in German statistics.

Estonia

Estonian whitefish landings in the Eurostat/ICES database are available since 1988. Additional data for the period 1928 to 1939 are extracted from monthly fisheries magazines and for 1945 to 2010 from archives of the Estonian Marine Institute and from official catch statistics. Recreational catch data is also included in these whitefish landings data.

Latvia

Data about Latvian landings in the Eurostat/ICES database are available for a short period from 1924 to 1931 and again from 1988 to the present. Additional information for the time period from 1973 to 2006 is taken from a Latvian statistical factbook (Anon. 2007).

Lithuania

Lithuanian landings are presented in the Eurostat/ICES database since 1997. Older Lithuanian catch statistics concerning Curonian Lagoon catches (1951 to 2000) were provided by Rimantas *Repečka* of Vilnius University. Data on Curonian Lagoon whitefish landings from 1914 to 1931 are included in German statistics.

Poland

Polish Baltic Sea catch data for whitefish in the Eurostat/ICES database is available only for the years 1921 to 1931 and from 2004 onwards. Information on whitefish catches from the Polish part of the Oder estuary from 1990 to 2009 is published in the Mecklenburg-Vorpommern fisheries yearbooks (Schulz 2000, Jennerich & Schulz 2011).

Germany

German Baltic Sea catches are presented in the Eurostat/ICES database for the periods 1914 to 1923, 1927 to 1932, and since 1970 (except for 1991 to 1996). Additional information for the time period from 1974 to the present is available from the Mecklenburg-Vorpommern fisheries yearbooks (Schulz et al. 1992, Schulz 1995, Schulz 2000, Jennerich & Schulz 2011).

Division into three main regions

To account for natural differences between sea areas, we divided the Baltic Sea into three main regions (Fig. 1.). Sweden and Finland are included in the northern Baltic Sea region, where dominant parts of whitefish landings are taken from the oligotrophic Gulf of Bothnia. The more eutrophic eastern Baltic Sea region includes Estonian and Latvian waters and also the Russian part of the Gulf of Finland. Finally, the lagoons and coastal areas of Lithuania, Russian Kaliningrad Oblast, Poland and Germany are included in the southern Baltic Sea region.

Results and discussion

Northern Baltic Sea region

The Swedish and Finnish Baltic Sea whitefish fishery is concentrated in the Gulf of Bothnia, where more than half of the Swedish and more than 90% of the Finnish whitefish landings are taken (Lehtonen 1981, Lehtonen & Böhling 1988, Anon. 2001, Awebro & Poulsen 2011). The main fishing grounds are located in the northernmost Bothnian Bay and in the Quark, but the southern part of the Gulf of Bothnia (the Bothnian Sea) and the Archipelago Sea between the Gulf of Bothnia and the Gulf of Finland are also important for whitefish fisheries (Lehtonen 1981, Lehtonen & Böhling 1988, Lehtonen & Jokikokko 2002, Heikinheimo & Mikkola 2004). The bulk of Finnish landings has been taken by commercial fishermen using gill nets, although the trap net fishery for whitefish has decreased during the second half of the twentieth century (Lehtonen 1981, Lehtonen & Jokikokko 2002, Aronsuu & Huhmarniemi 2004, Heikinheimo & Mikkola 2004). In recent decades the importance of recreational fishing in Finland has increased significantly and nowadays it is forming an almost equal part of whitefish catches in the Gulf of Bothnia as well in the Gulf of Finland (Koivurinta & Vähänäkki 2004).

Whitefish forms are not separated in catch statistics and in the case of mixed populations the proportions of two forms in local catches can only be evaluated after an advanced analysis of catch samples (Salojärvi & Auvinen 1980, Lehtonen 1981, Lehtonen & Böhling 1988, Heikinheimo et al. 2004, Koivurinta & Vähänäkki 2004). In the second half of the 1970s, anadromous whitefish comprised on average 33 to 38% of the total Finnish whitefish catches from the Baltic Sea, although this component varied significantly between different areas. Sea-spawning whitefish was dominant in the Bothnian Bay catches, while anadromous whitefish was more abundant in the Bothnian Sea and Quarken catches. In the Gulf of Finland and in the Archipelago Sea, catches of the two forms were approximately equal (Lehtonen 1981, Leskelä & Lehtonen 1992). As a result of intensive stocking, the proportion of anadromous whitefish gradually increased after the 1980s and near the turn of the century anadromous whitefish comprised 70 to 80% of the Gulf of Bothnia and 90% of the Gulf of Finland whitefish catches (Lehtonen & Böhling 1988, Aronsuu & Huhmarniemi 2004, Koivurinta & Vähänäkki 2004).



Fig. 1. Map of the Baltic Sea. Different regions are denoted by different shadings.

Sweden

Swedish annual whitefish landings in the early 1910s were below 100 t, although due to fragmentary data from the northern counties there is the possibility of a serious underestimation of the total whitefish catch in this period (Ojaveer et al. 2007, Awebro & Poulsen 2011). After the mid 1910s, annual landings reached approximately 500 t and exceeded recorded Finnish catches of this period (Fig. 2). A smoothly rising trend in whitefish landings can be observed up to the beginning of the 1950s when the annual landings reached a maximum of 857 t in 1951. After that, landings started to decrease and a continuous trend of smooth decline can be observed during the following 60 years.

In addition to the official statistics, a reconstructed estimation of the whitefish catch (comprising recreational, illegal, unregulated, unreported catches and discards in addition to the commercial landings) is available for the time period from 1950 to 2007 (Persson 2009, Persson 2010). Estimated recreational catches are almost five times higher than commercial catches and the pattern of reconstructed landings is more similar to the Finnish data, where recreational catches have been accounted for in the overall dataset since 1953 (Fig. 2.).

The example of Sweden shows that various grey literature sources can contribute important additional information in addition to officially reported whitefish landings statistics. If these are not taken into account, possible discrepancies between official landings and reconstructed total catches may be large enough to contribute substantial inaccuracies to future stock assessments.

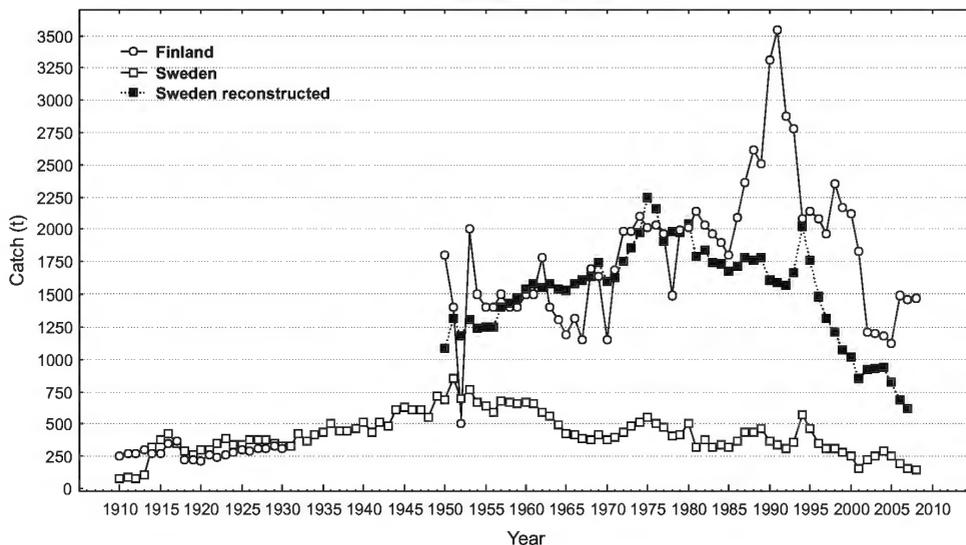


Fig. 2. Whitefish catches from the Northern Baltic Sea region from 1910 to 2009.

Finland

Finnish whitefish landings from the Baltic Sea were rather stable at a level of around 300 t during the 1910s and 1920s. Data are unavailable for the period from 1932 to 1949, but the average annual catch in the 1950s was much higher and exceeded 1,400 t. In the 1960s, catches of several anadromous whitefish populations began to decrease due to the closing of the spawning routes by hydropower dams and declining water quality (Hildén et al. 1982, Salojärvi et al. 1985, Lind & Peiponen 1988, Huhmarniemi & Aronsuu 2001, Aronsuu & Huhmarniemi 2004). However, this decrease had little or no effect on the total landings of whitefish, which were still annually around 1,400 t during this decade. In the 1970s, annual landings reached 1,800 t and in the 1980s they reached 2,000 t at least in part due to intensive stocking since the 1960s (Salojärvi 1984, Lehtonen & Böbling 1988, Lind & Peiponen 1988, Jokikokko & Huhmarniemi 1998). The biggest catches were recorded in the first half of the 1990s when annual landings exceeded 2,500 t and peaked in 1991 at 3,542 t. In the second half of the 1990s, annual catches were around 2,100 t but since the beginning of the twenty-first century they have decreased to the levels of the 1960s at less than 1,400 t per year (Fig 2). One of the main possible reasons behind the decrease in whitefish landings during the last decade is the growing grey seal (*Halichoerus grypus* (Fabricius)) population (Westerberg et al. 2000, Lehtonen & Suuronen 2004, Lundström et al. 2010). In addition to increased predation in the sea, seals also consume whitefish directly from fishing gears and often damage nets, which have led to a significant decrease in some local coastal fisheries (Westerberg et al. 2000, Heikinheimo et al. 2004, Koivurinta & Vähänäkki, 2004, Kauppinen et al. 2005, Suuronen & Lehtonen 2012). Decrease in landings in some areas in the Gulf of Bothnia and in the Gulf of Finland are found to be connected to changing fishing patterns, i.e. a reduction of the mesh size of nets and increased fishing effort (Aronsuu & Huhmarniemi 2004, Heikinheimo & Mikkola 2004, Jokikokko et al. 2007).

Eastern Baltic Sea region

Whitefish landings from this area have been significantly lower than from the northern region and even during the period of maximum catches in the mid-twentieth century they remained below 500 t (Fig. 3.). Similarly to the northern Baltic Sea area, both sea-spawning and anadromous forms of whitefish are present. Sea-spawning, sparsely-rakered whitefish with a mean count of 22 to 24 gillrakers had in the past at least seven different spawning populations reproducing near the Estonian western coast and around islands (Sörmus 1976a, Sörmus 1976b, Sörmus et al. 2003). The sea-spawning form also reproduces in Latvian coastal waters in the Gulf of Riga (Atis Minde, personal communication). A separate population of sparsely-rakered anadromous whitefish spawns in the Pärnu River of the Estonian western coast (Sörmus 1976a, Sörmus & Turovski 2003). Migratory whitefish also spawn in five Latvian rivers (Plikšs & Aleksejevs 1998). Densely-rakered anadromous whitefish occur in the eastern part of the Gulf of Finland (Prawdin 1931, Berg 1948). Information about the proportions of the different whitefish forms in the catches from this area is not available. However, coastal fish monitoring data from the last two decades collected by the Estonian Marine Institute show that densely-rakered whitefish with a mean count of 30 gill rakers,



Fig. 3. Whitefish catches from the Eastern Baltic Sea region from 1910 to 2009.

similar to those reproducing in the Finnish rivers, presently dominates in the Gulf of Finland and around the western islands.

Russian Federation

Russian data on annual landings from the Gulf of Finland are fragmentary, although catches were greatest in the 1950s and peaked at nearly 100 t in 1952. A rapid decline followed, down to 12 t at the beginning of the 1960s and to just a few tonnes in the mid-1960s. A subsequent increase in landings was observed in the late 1970s and early 1980s, probably due to stocking in Finnish waters. Total Russian Baltic Sea whitefish catch data are available for 1990s and 2000s. As whitefish catches from the Russian part of the Curonian Lagoon totally collapsed in the mid-1980s, these total figures consist predominantly of catches from the Gulf of Finland (Zableckis 1998, Guščin & Matašenko 2008). Thus, it can be estimated that annual landings from the Gulf of Finland during the last two decades have been below 10 t and exceeded 20 t only in the year 2000.

In the case of Russia, official data do not separate the Curonian Lagoon and the Gulf of Finland whitefish landings. Considering that both areas are inhabited by different whitefish populations, it is obvious that the inclusion of available grey literature sources is necessary in order to distinguish catches from different sea regions and to avoid erroneous stock management decisions.

Estonia

Estonian landings statistics from the late 1920s and the 1930s show a very rapid increase of annual whitefish catches to reach over 200 t in the mid-1930s. This increase can be explained, at least partially, by a gradual improvement in the data collection during the observed period. An incomplete correspondent network probably caused a severe underestimation of catches in the first years of that period, because local fisheries journals of this time report that intensive fishing in some spawning areas led to a noticeable decline of whitefish yield as early as the mid-1920s (Anon. 1927). No data are available for the first half of the 1940s because of the Second World War. Annual reported catches shortly after this time did not exceed 30 t, but landings increased rapidly at the start of the 1950s, most likely due to an increase in the fishing effort resulting from collectivisation of the fishing industry. Peak landings in the first half of the 1950s were resulted from the good condition of whitefish stocks and the replacement of cotton gill nets by more effective nylon ones (Sörmus 1976c, Sörmus & Turovski 2003). Catches subsequently started to decrease in the mid-1950s. A short-term increase observed at the start of the 1960s probably resulted from one very strong year-class of local sea-spawning whitefish, which recruited in 1960 and formed the bulk of landings during the first years of the 1960s (Sörmus 1961, Sörmus 1963, Sörmus 1964). Whitefish landings continued to decline during the following decades and reached their lowest level in the late 1980s. Small-scale stocking of local sea-spawning whitefish did not have any significant effect (Sörmus & Turovski 2003). A slight increase in the Estonian whitefish catches during the most recent decades is most likely due to the immigration of stocked whitefish from Finnish waters (Sörmus & Turovski 2003).

Latvia

Latvian whitefish landings are mainly taken from the Gulf of Riga while coastal waters of the open Baltic Sea are of less importance (Anon. 2007). Annual catches increased from several tonnes in the mid-1920s to more than 32 t in 1931. Data are absent for the period from 1932 to 1972. In the 1970s and 1980s, annual landings stayed mostly between 1 to 2 t but increased significantly during the early 1990s when the coastal sea was opened to small scale fishing and more than 20 t was caught in 1990. Since 1993, annual catches were stable in the range of 4 to 7 t up to the end of the century. During the last decade, annual landings have varied between 3 and 5 t.

Southern Baltic Sea region

Whitefish landings from the coastal waters of Lithuania, Russian Kaliningrad Oblast, Poland and Germany are relatively small when compared to those of other regions, mainly because of restricted spawning areas in brackish or freshwater lagoons and river estuaries (Fig. 4). Only the anadromous form occurs in this region (with a mean gillraker count of 29 to 33) (Manjukas 1963, Gaigalas 1972, Heese 1988, Vuorinen et al. 1991, Czerniejewski & Rybczyk 2010). Nowadays, most populations in this region are seriously suffering from a loss

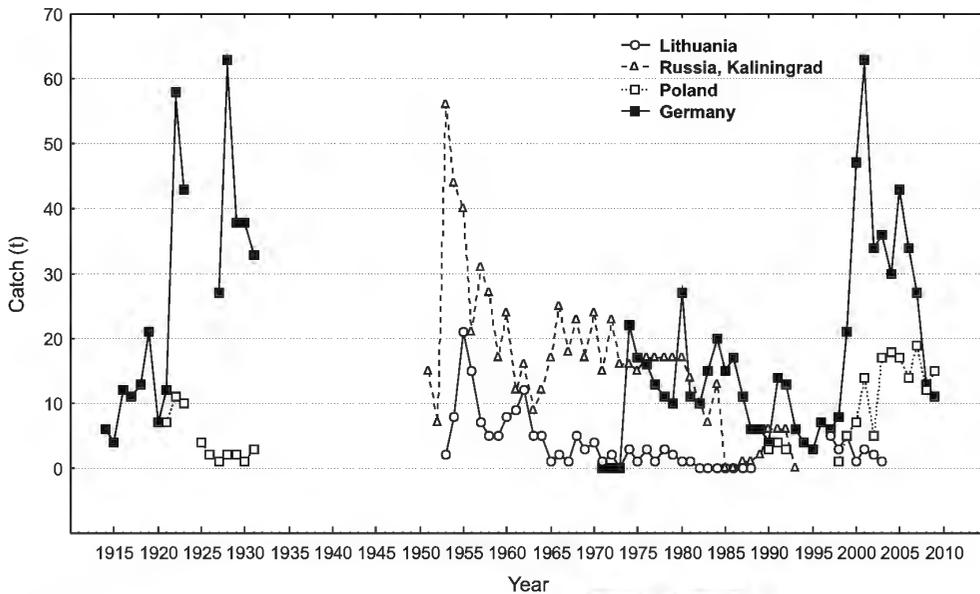


Fig.4. Whitefish catches from the Southern Baltic Sea region from 1910 to 2009.

of spawning grounds due to eutrophication (Heese 1988, Schulz et al. 1992, Schulz 2000, Czerniejewski & Rybczyk 2010).

Lithuania

The Lithuanian Baltic whitefish landings are predominantly taken from the Curonian Lagoon. Between 1928 and 1936, total annual landings fluctuated between 17 and 100 t with a mean value of 42 t (Gaigalas 1972). After the Second World War, catches from the Lithuanian part of the Curonian Lagoon reached a maximum in the mid-1950s when 21 t were caught in 1955. In the second half of the 1950s catches decreased rapidly, but a short-term increase followed in the beginning of the 1960s similarly to the catches from Estonia and Russia during that time period. Thereafter, catches declined to a low level of 1 to 3 t during the 1970s and then totally collapsed in the beginning of the 1980s after which only some hundred kilograms have been taken annually. Between 1982 and 1994, no whitefish landings were recorded, but since 1995 0.1 to 0.5 t are caught annually from the Lithuanian part of the Curonian Lagoon and 0.4 to 3.7 t from the neighbouring Baltic Sea (Zableckis 1998, Repečka, personal communication).

Kaliningrad Oblast

Catches in the Kaliningrad Oblast from the Curonian Lagoon have been bigger than in Lithuania since the end of the Second World War. Peak landings of 56 and 50 t were taken in the years 1953 and 1954, respectively. Annual catches decreased to about 20 t during the 1960s and 1970s, and then decreased further to less than 10 t in the beginning of the 1980s. A slight increase in annual catches occurred in the late 1990s up to between 3 to 5 t. During the last decade, annual landings dropped to a level of several hundred kilograms (Guščin & Matašenko 2008).

Poland

Polish Baltic Sea catches are based mainly on migratory whitefish spawning in the Oder River estuary (Heese 1988, Czerniejewski et al. 2010). The registered annual catch in Poland during the 1920s was quite low and only occasionally exceeded 10 t. Information about landings is lacking for most of the twentieth century. However, a significant decrease in catches can be observed in the 1980s which is probably due to eutrophication of the spawning grounds and cessation of stocking. During the last decade, annual catches have increased in the Oder estuary to the range of 10 to 12 t (Czerniejewski et al. 2010). Total annual landings from the Polish coast increased from 3 to 5 t in the late 1990s to approximately 15 t in the 2000s.

Germany

German whitefish catches predominantly originate from brackish water lagoons and estuaries of the Mecklenburg-Vorpommern area. The main spawning population inhabits the Oder River estuary (Czerniejewski et al. 2010, Schulz et al. 1992, Schulz 2000, Schulz 2008, Jennerich & Schulz 2011). According to the catch statistics available for the first half of the twentieth century, annual whitefish yield increased from less than 10 t in the mid-1910s to nearly 50 t in the mid-1920s with a peak catch of 63 t in 1928. It should be noted that the German catch data from the time period 1914 to 1931 also included East Prussia's Curonian Lagoon landings and therefore are not fully comparable with latter German data. We have no data on whitefish catches for the period from 1932 to 1969. A total of 39 t was caught from the German Baltic coast in 1970 (Schulz 2000). A trend of gradual decline in the whitefish catch can be observed through the period from the 1970s to the beginning of the 1990s. Landings reached their all-time low in the mid-1990s, when only 3 t were caught in 1990 (Schulz 2000). Stocking of whitefish to the Oder Estuary began in 1993 and a rapid catch increase was observed in the late 1990s, exceeding 60 t in 2001 (Schulz 2008). Landings have considerably decreased in some recent years, probably due to reduced stockings (Jennerich & Schulz 2011).

Considering all of the above issues, we consider that reconstructed and critically valuated whitefish landings data when combined with official and grey literature sources allows for the more realistic estimation of the actual fishing pressure on whitefish stocks during the last century. Furthermore, this knowledge can be used as background information for population

management decisions and in studies on whitefish population ecology such as confirming the timescales of potential genetic bottlenecks.

Conclusions

The reconstruction of a concise pattern of the Baltic Sea whitefish landings during the last century is difficult due to gaps in statistics. However, it is possible to follow general trends which are more similar in the southern and eastern Baltic Sea regions. Increasing fishing effort and modernisation of fishing gear in the first half of the twentieth century resulted in increased landings, although these lasted only a short time due to rapid overfishing of whitefish populations. The interruption of fishing by the Second World War postponed the exhaustion of the whitefish stocks for nearly a decade and the overall decline in whitefish catches in most areas started in the mid-1950s. Subsequently, the increasing eutrophication of the Baltic Sea and the effective closing of rivers by hydropower stations during the 1960s and 1970s hampered whitefish spawning and many populations collapsed in the 1980s, especially in the southern and eastern Baltic Sea regions. Intensive stocking in Finland increased Finnish landings to record high levels near the end of the twentieth century and the effects of Finnish stocking can also be seen in the catches of neighbouring countries. Stocking has also increased German and Polish whitefish landings during recent decades. The Baltic Sea whitefish populations, except some of the northernmost ones, are currently in poor condition and catches are considered by a number of authors to depend on stocking (e.g., Jokikokko & Huhmarniemi 1998, Schulz 2000, Heikinheimo et al. 2004, Jennerich & Schulz 2011).

When comparing the importance of regions in whitefish fisheries, the Northern Baltic Sea region share has always been dominant. Roughly 80% of landings were taken from this area as long ago as the first half of the twentieth century, when whitefish stocks across the Baltic Sea were in fairly good condition. Since the 1950s, the share of the Northern Baltic Sea region in the whitefish catches increased and during the 1980s and 1990s as much as 97 to 99% of total catches originated from that area. The highest landings from the Baltic Sea occurred between 1988 and 1993 when more than 3,000 t of whitefish were caught annually with a peak in 1991 of 3,913 t. With the addition of reconstructed Swedish landings by Persson (2009), we can assume that the total Baltic Sea annual whitefish landings during the 1970s, 1980s and 1990s often exceeded 4,000 t and in some years such as 1991 more than 5,000 t were landed (Table 1). The overall situation in the Baltic Sea whitefish stocks is rather similar between the regions. Several stocks have collapsed, while others show signs of a more gradual decrease despite stocking. However, the long-term development towards this situation has had some regional and temporal differences.

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