

GERMANY'S MARINE FISHERIES CATCHES IN THE BALTIC SEA (1950-2007)¹

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ABSTRACT

Total fisheries catches by Germany in the Baltic Sea from 1950-2007 were estimated using a method called 'catch reconstruction' that used ICES landing statistics as a baseline, then adjusted these data based on data available from other sources such as ICES stock assessment working group reports and national data, unreported landings, discards, and recreational fishing. Cod (*Gadus morhua*) contributed the largest proportion of unreported landings, discards, and recreational catches, although herring (*Clupea harengus*) is also an important commercial species. The reconstructed catch from 1950-2007 was approximately 36% higher than catches attributed to Germany by ICES landing statistics for the same time period. We believe that this reconstruction remains a conservative estimate. Overexploitation of marine resources, either legally or illegally, is a serious problem in many areas of the world including the Baltic Sea. Comprehensive accounts of total catches (in contrast to reported commercial landings only) as well as full public transparency of all data collection, the scientific advice and political decision process will be crucial in any efforts to move towards ecosystem-based management of the Baltic Sea.

INTRODUCTION

The Federal Republic of Germany has coastlines both along the Baltic and North Seas (Figure 1). With an area of approximately 357,000 km², and a population of 82.6 million (UN, 2009), Germany is not only Europe's second most populous nation, but its strongest economically. After World War II, Germany was divided into the Federal Republic of Germany (FRG) also known as 'West Germany' and the German Democratic Republic (GDR) also known as 'East Germany'. The western state (FRG) became involved with western economic and security organizations, and was a founding member of the European Commission (EC) in 1957 (which became the European Union [EU] in 1993). The GDR was part of the Soviet aligned eastern bloc. At the end of the Cold War in the early 1990s, the country was re-unified under the banner of the Federal Republic of Germany. Though the marine fishing industry has never contributed significantly to the GDP (0.13%), Germany runs substantial deep-sea operations in the North Atlantic and North Sea, as well as small-scale fisheries in the Baltic Sea (Anon., 2007b). German fishers mainly target sprat (*Sprattus sprattus*), herring (*Clupea harengus*), cod (*Gadus morhua*), and flounder (*Platichthys flesus*) in the Baltic Sea, with reported landings in 2007 totaling approximately 73,000 tonnes (t) annually (UN, 2009).

The German Baltic fleet is comprised of cutters and coastal fishing boats. The total number of vessels doubled after reunification in the 1990s, but capacity (gross tonnage) has since been decreased by about 40%. In 2004, there were a total of 445 cutter and coastal vessels targeting herring (a mixture of fixed and trawl gear), 27 vessels targeting sprat (trawls), and 573 vessels targeting cod (gillnet and trawl). In 2003, there were approximately 2,200 registered vessels and 4,000 commercial fishers (Anon., 2007b). Though there is little information in the literature about recreational fishing in Germany, angling for cod, flounder and herring is well-established (Anon., 2007a). Authorities have since 2005 been in the process of conducting surveys to obtain quantitative information on these fisheries (ICES, 2005). In addition, marine

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recreational fishers also target mackerel (*Scomber scombrus*) and garfish (*Belone belone*; Pawson *et al.*, 2007). It is estimated that there are approximately 113,000 to 147,000 active anglers along the coastal waters of the Baltic (Anon., 2007a).

Cod was the main species fished commercially by Germany until the late 1980s, but with declines in cod stock abundance and more restrictive management quotas, herring and sprat have become the main species landed by Germany in the most recent decade. However, German fishers still account for approximately 32% of cod landings in the western Baltic (Menn, 2006). The western stock is targeted primarily by trawl and gillnets while the eastern cod stock is mainly fished by trawl. Prior to the 1990s, the majority of cod was taken by gillnet, but a change in stock age composition has resulted in more predominant trawl use since the early 2000s (Anon., 2007b). Though most flounder is caught as bycatch in the cod fishery, Germany also has a flounder-directed fishery (ICES, 1991).

The only fishery which appears not to have peaked, as of 2007, is the sprat fishery. Though Germany's landings of sprat have fluctuated greatly since the 1950s, reported landings in the 2000s exceed those of any other decade for the period 1950-2007. In comparison, herring and cod landings in the 2000s are below average and less than half what they were in the 1960s. The reunification of Germany caused many difficulties for fishers from East Germany who were accustomed to an industry based on public property and subsidies. Reduction of fisheries production was one of the primary goals for integration, and as fleet capacity was reduced under the EU Common Fisheries Policy (CFP), unemployment escalated. A unified Germany also inherited an economically inefficient, over-sized, and ageing fleet from East Germany which did little to aid a smooth transformation in market structure (Cannarella, 1997).

Management efforts for commercial species have been somewhat complicated since reunification in the early 1990s. Fishers from West Germany became authorized to fish in East Germany's fishing areas, resulting in significant overfishing of local cod stocks. Harmful fishing behaviors have also developed since this time. Prior to reunification, there were very low discards or Illegal, Unreported and Unregulated fishing (IUU) due to strict regulation by national authorities in East Germany. Most fish species had similar financial values, and all were delivered to national authorities prior to being sold on the market (R. Oeberst and J. Heinrich, pers. comm., Johann Heinrich von Thünen-Institut). Since reunification and transformation to a market economy and the rules of the CFP, unreported catches and discards have become an economic reality.

As in all EU member states, CFP policies and TAC shares are administered nationally. Germany's Sea Fisheries Act dictates a national management strategy, which has generally aimed to reduce overall fishing effort in recent years. One of the primary rules states that an individual or organization may only be issued a fishing license if the vessel was already in service in 1986 or 1987. New vessels require consent of the Federal Ministry of Food, Agriculture and Consumer Protection, and must replace a vessel which is larger, more powerful, or less efficient. There are two types of fishing licenses issued by the German ministry: 1) general fishing licenses; and 2) individual fishing licenses. A general fishing license permits a license holder for a given fishery to fish with no restrictions (within the national TAC share), until permission is revoked. This is generally used for species for which the national TAC share is not expected to quickly be exhausted. An individual license is more restrictive and is generally used for more vulnerable species such as Baltic cod and saithe (*Pollachius virens*). This license permits a catch of a set amount from a set fishing

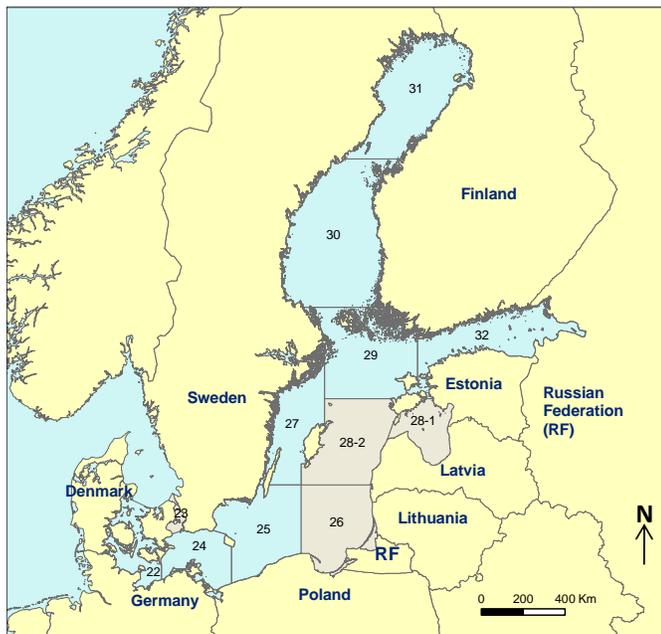


Figure 1. Map of the Baltic Sea with ICES subdivisions and surrounding countries. Germany's coastline borders ICES subdivisions 22 and 24.

area. One other type of common management strategy is the specification of a weekly or monthly total allowable catch which is usually delineated per fisher, per fishing journey. The intent of this strategy is to prevent early exhaustion of national quota shares (Anon., 1997).

Monitoring of the German quota follows the rules set for all EU member states. Every vessel greater than 10 meters must keep a logbook with details of the species, amount, area and time fished. As in other countries, there is no independent confirmation of logbooks or reported catches, such as compulsory onboard observer programs. Individuals who are responsible for the marketing of landed fishery products are required to deliver invoices to the authorities (Anon., 1997). Though there is no management strategy for marine recreational fishing in Germany, anglers require a permit to go fishing for any commercially targeted quota species in coastal or offshore waters, and all sales of recreationally caught fish are illegal. The species targeted by recreational fishers which are subject to EU quotas are mainly cod and herring. Rules vary slightly between coastal states, but generally speaking, minimum age and ticketing qualifications are set on top of mandatory compliance with minimum mesh size and effort regulations set for commercial fishers (Pawson *et al.*, 2007).

The purpose of this study is to provide an estimate of the total fisheries catches (reported landings + IUU) in the Baltic Sea by Germany for the period from 1950-2007. The ICES catch statistics database (ICES, 2009) (which we will refer to here as the 'ICES landings statistics') offers time series data on marine landings for Germany from 1950-2007. The title, 'ICES landings statistics', seeks to represent the true nature of the data presented, as no apparent effort has been made to fully represent total catches (which would include IUU as opposed to reported landings only). Our reconstruction attempts to estimate four main components of IUU including: a) data source adjustments to reported landings; b) unreported landings; c) discards; and d) recreational catches. Our approach utilizes previously reported data by ICES, a review of the peer-reviewed and grey literature, and correspondence with local experts.

METHODS

Germany was treated as two separate entities for the time period 1950-1990 to reflect the existence of East and West Germany as two distinct jurisdictions during this time period. Here we present information concerning the two Germanys separately for the earlier time period (1950-1990), and after re-unification in 1991, the two former states are treated as 'Germany'.

The general method involved adding Illegal, Unreported and Unregulated (IUU) estimates of various kinds to the 'ICES landings statistics', which are treated here as representing the 'officially reported data set' that is publicly available, covers all reported taxa, all countries, all Baltic Sea statistical areas, and all years of concern (1950-2007). We thus treat anything not part of ICES landings statistics as IUU. The various IUU components as applied here are: a) *adjustments*: these were made to account for other known landings as reported by national data sources or stock assessment sources; we undertake 'Adjustments to ICES landings data' from these alternate data sources in certain years, with the result being what we consider to be the best estimate of commercial landings; b) *unreported* landings (referred to by ICES as 'unallocated' catches): which were estimated separately during the period when Germany existed as two entities; c) *discards*: which were estimated as rate and then applied to the estimated total landings (i.e., ICES landings statistics + landings adjustments + unreported catches); and *recreational* catches: which were also estimated separately. Thus, reconstructed total catch estimates include more comprehensive accounting of reported landings, unreported landings (commercial as well as recreational), as well as discarding than the officially reported data made readily available to the general public via the ICES landings statistics.

ICES landings statistics

ICES landings statistics for Germany (ICES, 2009) for the time period 1950-1972 are reported separately for East Germany and for West Germany. ICES landings data for West Germany begin in 1950 and continue until 1990. ICES landings statistics for East Germany cover the time period 1961 to 1990, with the 1973-1990 period being reported as Germany (Neue Länder)². Since 1991, Germany's landing statistics are reported to ICES as a single country because of the re-unification of the two former separate countries.

² Neue Länder (= "new states") refers to the fact that upon incorporation into the Federal Republic of Germany, the former East Germany was split into states (Germany is a federation) or Länder.

Illegal, Unreported and Unregulated (IUU) catches

Illegal, Unreported and Unregulated (IUU) catches are here considered entirely with respect to the ICES landings statistics, and included: a) *Adjustments* are made to the ICES landings statistics to account for more detailed data on commercial landings available from other highly recognized sources, such as stock assessment reports or national datasets; b) Estimates of *unreported* catches (in ICES terminology ‘unallocated’ catches), which are derived using ratio information based on ICES landings statistics plus ‘adjustments’; c) *Discard* rates are applied to the sum of ICES landings statistics plus adjustments plus unreported catches; and d) *Recreational* catches are estimated separately. Thus, total reconstructed catches are formed from the sum of ICES landings statistics and the four estimates outlined above.

Adjustments to ICES landings statistics

Adjustments were made to ICES landings statistics in order to present the best estimate of commercial landings. Adjustments to ICES landings statistics are based on unpublished data provided by our co-author from Germany (C. Hammer, unpubl. data) and from ICES stock assessment working group data. Adjustments were made to the landings data throughout the study period, but were more substantial in the earlier time periods.

East Germany’s landings data for all taxa are not presented in ICES landings statistics for the period 1950-1960, except salmon landings which are not presented in ICES landings statistics until 1963. Thus, adjustments during this early time period accounted for the landings of all taxa by the former East Germany. Adjustments for herring, sprat, salmon, flatfishes, and ‘others’ were based on the average of the first three years of reported data. Adjustments for cod during this early time period were based on information from our collaborator in Germany who provided data regarding landings of cod, and we used this data as a source of adjustments for 1950-1964 (Hammer *et al.*, 2008). After the 1950s and early 1960s, adjustments were only made to ICES landings of cod, flatfishes and taxa in our group ‘others’ for East Germany originated from ICES stock assessment working group data (ICES, 2007; 2008a).

Adjustments to ICES landings statistics for West Germany for cod (from 1965 onwards) as well as flatfishes (mostly from the 1990s onwards), were based on ICES stock assessment working group data (ICES, 2007; 2008a).

Unreported landings

Unreported landings were estimated separately for East Germany and West Germany. After reunification, Germany’s unreported landings were estimated by continuing the methodology used for West Germany.

When East Germany was a part of the eastern bloc (1950- 1990) and had a state-controlled economy, we assumed that there were no unreported landings because of the consequences of non-compliance and a similar price was paid for whatever was landed. For West Germany (1950-1990) and Germany (1991-2007), estimates of unreported landings were formed from what ICES refers to as ‘unallocated’ catches, and also from assumed values. The general approach was to convert unreported landings into a percent of the landings reported for the respective taxa, and to apply this unreported landings percent to the sum of ICES landings and adjustments. In order to expand to time periods and to taxa that were not covered by ICES, we used an assumption-based method. ICES reports unreported landings of cod (ICES, 2007; 2008a), and salmon (ICES, 2008b), and we use these to estimate unreported landings for all other taxa.

Table 1. Anchor points (%) used for estimating unreported landings for eastern and western cod stocks for West Germany (1950-1990), and for Germany (1991-2007) based on sources (Tables 2.3.1 and 2.4.1 in ICES, 2007; Tables 2.3.1 and 2.4.1 in ICES, 2008a). Dashed (-) lines indicate years when linear interpolations were used.

Year	Cod stocks	
	western	Eastern
1950	5.00 ^a	5.00 ^a
1951-1979	-	-
1980	20.10 ^b	31.10 ^b
1981-1992	-	-
1993	40.20	62.20
1994	39.64	102.55
1995	-	29.68
1996	5.34	10.30
2000	-	46.00
2001	-	47.55
2002	-	46.62
2003	-	61.46
2004	0.07	52.91
2005	0.04	46.41
2006	0.04 ^c	46.91
2007	0.04 ^c	43.17

^a assumed discard rate; ^b assumption of one-half the 1993 rate; ^c 2005 value

Table 2. Anchor points in % used for estimating unreported landings for salmon for West Germany (1950-1990), and for Germany (1991-2007) based on sources (ICES, 2008b). Dashes (-) indicate years when linear interpolations were used.

Year	Anchor point	Year	Anchor point
1950	5.0 ^a	1994	18.7
1951-1980	-	1995	19.5
1981	20.4	1996	20.4
1982	20.7	1997	20.8
1983	22.6	1998	20.1
1984	20.7	1999	20.4
1985	19.7	2000	19.9
1986	22.0	2001	20.4
1987	21.4	2002	20.5
1988	22.2	2003	20.1
1989	22.6	2004	20.6
1990	24.4	2005	20.7
1991	19.5	2006	22.2
1992	20.1	2007	21.4
1993	19.4		

^a assumed default.

data provides information on Baltic-wide unreported landings of salmon, and these were transformed into rates as a percentage of the reported landings presented in the same report (see 'Methods' in Zeller *et al.*, this volume). We used our assumed default rate of 5 % for 1950 and interpolated linearly to the 1981 anchor point (Table 2).

Other taxa: Other taxa, which here comprise sprat, herring, flatfishes, and the group 'others' had unreported landings estimated as well. We used our assumed default rate of 5 % for 1950, and derived anchor points in 1993 and 1994, and for 2004 and 2005 from years when there were anchor points of unreported landings for each cod stock and salmon. We averaged the rates for these years and then reduced this rate by 50 % to derive anchor points in 1993, 1994, 2004, and 2005 (Zeller *et al.*, this volume). The rate for 2005 was used to estimate unreported landings for the last two years (Table 3).

Discards

Discards were divided into four categories, with each assessed individually: 1) underwater discards account for the mortality of fish lost from gear while it is actively deployed for fishing; 2) fish caught as a result of ghostfishing by gear that is lost; 3) boat-based discards usually resulting from fishers' behavior after the catch is brought on board; and 4) discards estimated to account for fish damaged by seals. Seal damage is considered to be not an important issue in Germany and thus, here we estimate the first three categories (1-3).

Underwater discards: Underwater discards were applied to the sum of ICES landings, adjustments, and unreported landings from 1950-2007 for all German catches of herring and sprat only. Sprat and herring are caught by the same fleet (ICES, 2007). Inaccurate catch composition data due to the mixed nature of this fishery, and the fact that these two species are targeted by the same fleet, led us to apply the underwater discard rate to both species combined.

Our estimates for underwater discards of herring and sprat were based on a Finnish trawl study by Rahikainen (2004) from which we derived an underwater discard rate for herring of approximately 9% (see 'Methods' in Zeller *et al.*, this volume). However, we applied a more conservative rate of 5% to their estimated catches (ICES landings + adjustments + unreported catches) of herring and sprat because German catches by gear type were not available.

Cod: Some estimates of unreported ('unallocated') landings were reported in ICES stock assessment working group data (ICES, 2007) separately for both the western and eastern cod stocks. Unreported landings of cod from the western cod stock are reported for the years 1993, 1994, 1996, 2004 and 2005. Unreported landings of the eastern cod stock were reported for the periods 1993-1996 and for 2000-2007 (Table 1). The anchor points for 1950 and 1980 were assumption-based anchor points. The 1950 value was our assumed default rate, and the 1980 anchor point was assumed to be half the 1993 value, which was based on information from ICES stock assessment working group data. All anchor points were transformed into rates based on the unreported totals as a proportion of landings from the same ICES working group reports.

Salmon: Unreported landings of salmon were reported in ICES working group data from 1981 to 2007 (ICES, 2008b). The

Table 3. Anchor points in % used for estimating unreported landings of other taxa for West Germany (1950-1990), and for Germany (1991-2007) based on sources (Tables 2.3.1 and 2.4.1 in ICES, 2007; Table 2.1.2. in ICES, 2008a). Dashed lines (-) indicate years when linear interpolations were used.

Year	Anchor point
1950	5.0 ^a
1951-1993	-
1994	20.3
1995	26.9
1996-2003	-
2004	12.3
2005	11.2
2006-2007	11.2 ^b

^a assumed default value; ^b 2005 value

Ghostfishing: Catches (mortality) of fish due to ghostfishing were treated as discards. Tschernij and Larsson (2003) studied the capture of cod due to the loss of fishing gear (gillnets) in Sweden's marine waters and related it to commercial landings. Here we use the mean value (1.65%) between the low (0.01%) and high (3.2%) estimates as presented in Brown (2005). Ghostfishing rates were applied to the catches of all species, excluding herring and sprat, during the entire time period, 1950-2007 and were applied to ICES landings statistics + adjustments + unreported catches.

Boat-based discards: Boat-based discards usually resulting from fishers' behavior were also estimated. However, during the period before re-unification, estimates of East and West Germany's discarding rates were treated in a different manner because of political and economic differences. In East Germany it was assumed that discarding was minimal due to the lack of economic incentives for discarding as it was officially illegal to discard and same price was paid for all edible species, hence it is likely that only damaged or unpalatable fish were discarded (R. Oerberst, pers. comm., Johann Heinrich von Thünen-Institut). Therefore, we assumed a discard rate of 2% for the 1950-1990 time period, applied to all species. We linearly interpolated from 2% to the first anchor point established in 1993. This is conservative in comparison with discard rates of 6% observed in Norway, where it is illegal to discard (Krog, 2001).

Boat-based discard rates for West Germany were considered to be higher than those for East Germany due to its market-oriented economy, and associated discarding incentives. Discard rates of the eastern and western cod stocks, and salmon followed the assumption-based approach as outlined in Zeller *et al.* (this volume), with anchor points being developed from ICES working group data (Table 4, 5). Taxa that formed part of our groups 'others' and flatfish were assigned discard rates according to taxa-specific information from a Danish study which documented the discarding practices over a one-year period for the entire Danish fleet (Anon., 2006a), and here we use these rates throughout the time period (1950-2007). Rates of discards for brill and turbot had the average rate (38.5%) from dab (33.4%), European flounder (48.0%) and European plaice (34.0%) applied, and we also used this average rate for our flatfish group (Zeller *et al.*, this volume). Whiting, which formed part of our group 'others', had a species-specific discard rate of 36.1% and all other taxa had a discard rate of 6.2%.

Table 4. West Germany's anchor points (%) used for estimating boat-based discards of eastern and western cod stocks from 1950-2007 based on sources (Tables 2.3.6, 2.4.1, and 2.4.5b in ICES, 2007; Tables 2.3.1, 2.3.6, 2.4.1, 2.4.5b, 2.4.20, and Figure 2.3.1 in ICES, 2008a). Dashed lines (-) indicate years when linear interpolations were used. East Germany's discard rates were 2 % from 1950-1990 and were then linearly interpolated to the first anchor point presented here in 1993.

Year	Cod stocks		Year	Cod stocks	
	Western	Eastern		Western	Eastern
1950-1965	65.1	10.21	1987	20.8	5.9
1966	65.1	9.4	1988	10.2	4.5
1967	65.1	12.6	1989	7.8	1.9
1968	65.1	8.6	1990	7.9	3.0
1969	65.1	9.8	1991	9.6	2.2
1970	71.5	6.8	1992	19.2	3.5
1971	57.0	4.9	1993	14.5	3.5
1972	66.9	12.7	1994	10.6	2.1
1973	21.3	8.9	1995	11.3	1.7
1974	42.6	10.5	1996	15.7	1.2
1975	22.4	10.4	1997	10.0	3.9
1976	18.3	2.3	1998	17.4	3.4
1977	25.6	1.6	1999	11.6	2.5
1978	27.5	15.5	2000	12.5	6.8
1979	10.8	16.0	2001	11.2	3.2
1980	17.1	3.6	2002	10.4	2.2
1981	13.8	1.6	2003	15.8	2.8
1982	35.3	5.9	2004	10.1	1.8
1983	40.7	4.5	2005	18.6	3.0
1984	17.9	2.4	2006	8.6	13.2
1985	7.2	3.1	2007	8.3	11.4
1986	15.3	1.2			

Table 5. West Germany's anchor points (%) used for estimating boat based discards for salmon from 1950-2007 based on Table 2.1.2 in ICES (2008b). East Germany's discard rates were 2% from 1950-1990 and were then linearly interpolated to the first anchor point presented here in 1993.

Year	Anchor point	Year	Anchor point
1950-1980	14.4	1994	12.9
1981	13.9	1995	13.9
1982	14.0	1996	15.1
1983	15.3	1997	14.9
1984	13.9	1998	14.2
1985	13.3	1999	14.8
1986	14.9	2000	10.3
1987	14.5	2001	15.0
1988	14.7	2002	15.8
1989	15.1	2003	15.4
1990	17.3	2004	15.6
1991	13.6	2005	15.2
1992	14.1	2006	17.4
1993	14.1	2007	14.2

Recreational catches

Recreational catches were not estimated for East Germany since it was illegal to participate in this activity (R. Oerberst, pers. comm., Johann Heinrich von Thünen-Institut). Thus, for 1950-1990, recreational catches were estimated for West Germany only, and for the reunified Germany from 1991-2007. The approach taken here is based on the number of fishers and catch rates (i.e., catch-fisher⁻¹) for the two states (Länder) bordering the Baltic Sea (Schleswig-Holstein and Mecklenburg-Vorpommern). In 2005 and 2006, the numbers of fishers and the catch of cod, flounder and herring were reported by the Institut für Ostseefischerei Rostock (Anon., 2007a) for the coastal states of Schleswig-Holstein (a state in former West Germany) and Mecklenburg-Vorpommern (a state in former East Germany). The numbers of fishers in Schleswig-Holstein reported for the two years were averaged (63,500 fishers) and we assumed that the number of fishers in West Germany in 1980 was half this average determined for 2005 and 2006, and in 1950, the numbers of fishers was assumed to be 25% of the average. For the state that was a part of East Germany, the numbers of fishers was also determined (73,500) from the two years of reported data, and for 1990 we set the number of fishers to zero and linear interpolations were done between years. Annual catch rates were held constant and were 23.4 kg-fisher⁻¹ for cod, 0.5 kg-fisher⁻¹ for flounder, and 1.8 kg-fisher⁻¹ for herring.

RESULTS

ICES landings statistics, which here incorporate the landings of East Germany, West Germany, and reunified Germany, reported a total of 4,221,739 t between 1950 and 2007 (Figure 2; Appendix Table 1). Reported landings were, on average, 40,000 t-year⁻¹ until 1960, after which there was a substantial increase to over 100,000 t-year⁻¹ by the mid-1960s, and were maintained at this level throughout most of the 1970s and 1980s. Reported landings decreased dramatically in the early 1990s to an average of approximately 30,000 t-year⁻¹, and remained at that level until the early 2000s when reported landings increased again to approx. 72,000 t by 2007 (Figure 2).

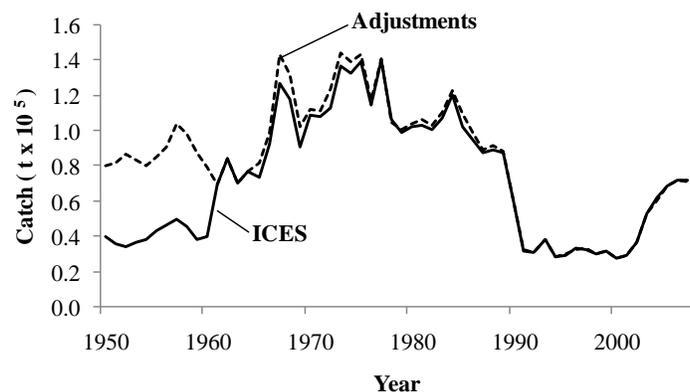


Figure 2. ICES landings statistics and adjustments to ICES landings statistics for Germany from 1950-2007.

Illegal, Unreported and Unregulated (IUU) catches

All catches that were not reported in the publicly available ICES landings statistics (ICES, 2009) were considered either Illegal, Unreported or Unregulated catches. The components included in our estimates of IUU catches were: a) 'adjustments' to ICES landings statistics for reported commercial landings from other reliable sources such as ICES stock assessment working group data or national data sources; b) 'unreported' ('unallocated') landings; c) 'discards'; and d) 'recreational' catches. Combined, these components formed the basis for our reconstruction.

Table 6. Total reported data adjustments (tonnes) to ICES landings statistics for Germany from 1950-2007.

Common name	1950-1959	1960-1969	1970-1979	1980-1989	1990-1999	2000-2007
Cod	173,646	65,331	25,430	29,435	-137	-1,932
Herring	91,560	9,156	0	0	0	0
Sprat	115,677	11,568	0	0	0	0
Flatfishes	35,597	3,708	1,478	20	2,357	19
Salmon	178	53	1	0	0	0
'Others'	51,623	5,162	8,680	0	0	0

Adjustments to ICES landings statistics

ICES landings statistics were adjusted using information obtained from ICES stock assessment working group data and from national sources (see methods for details). The largest adjustments to the ICES

landings statistics were in the first two decades of the study period, with over half of the overall adjustments occurring in the 1950s (Figure 2, Table 6). These adjustments were primarily due to the large proportion of cod landings taken by Germany in the Baltic Sea that were not represented in ICES landings statistics, but were reported in the ICES stock assessment working group reports. Herring and sprat also contributed substantially to the adjustments, particularly in the 1950s. From 1950-2007, adjustments to ICES landings statistics totaled 794,052 t (Figure 2).

Unreported landings

Unreported landings totaled 342,486 t over the 1950-2007 time period (Figure 3). Unreported landings increased from about 2,000 t·year⁻¹ in 1950 to a peak of approximately 16,700 t·year⁻¹ in 1984, thereafter declining to an average of around 7,000 t·year⁻¹ throughout the 1990s and 2000s. The greatest proportion of unreported landings was of cod, which represented roughly 58% of all unreported landings over the study period (Table 3). Herring, sprat, flatfishes, 'others' and salmon represented 27%, 6%, 4%, 4% and less than 1% of the total unreported landings for the period 1950-2007, respectively. The unreported landings of herring increased over the study period, with the highest levels in the early 1990s (Table 7). Unreported landings of sprat were, on average, 120 t·year⁻¹ until the early 2000s, after which unreported landings increased dramatically to over 3,000 t·year⁻¹. During the study period, unreported landings of flatfishes increased from 22 t·year⁻¹ in 1950 to the highest estimated level of over 1,800 t·year⁻¹ in 1994. Unreported salmon landings were highest in the 1960s with a total of 271 t for that period (Table 7).

Discards

Total discards of all species for Germany from 1950-2007 were estimated at 494,694 t (Figure 4). Discards were substantial throughout the study period, but were highest from the mid-1960s to the early 1970s with an average of approximately 15,000 t·year⁻¹. Cod represented the largest proportion (56%) of discards and were highest in the 1965-1972 time period when

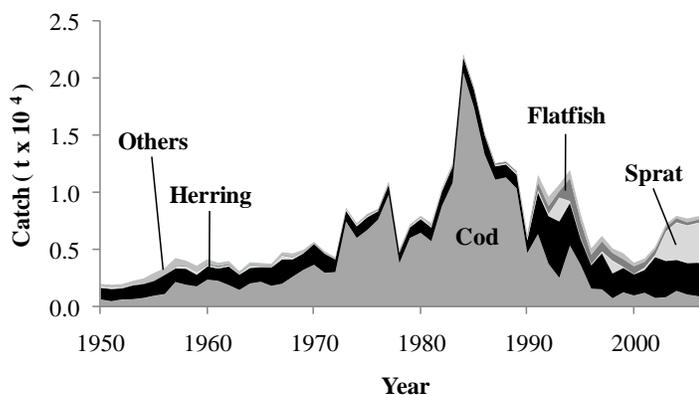


Figure 3. Germany's unreported landings by taxa, 1950-2007.

Table 7. Total unreported landings (tonnes) of commercially targeted species in Germany from 1950-2007.

Common name	1950-1959	1960-1969	1970-1979	1980-1989	1990-1999	2000-2007
Cod	10,110	19,780	47,008	87,287	27,148	8,021
Herring	11,591	12,886	9,403	10,836	25,508	21,600
Sprat	698	713	500	698	3,382	16,153
Flatfishes	448	712	696	872	7,988	3,245
Salmon	24	271	120	83	84	48
'Others'	3,984	2,238	689	729	4,946	2,287

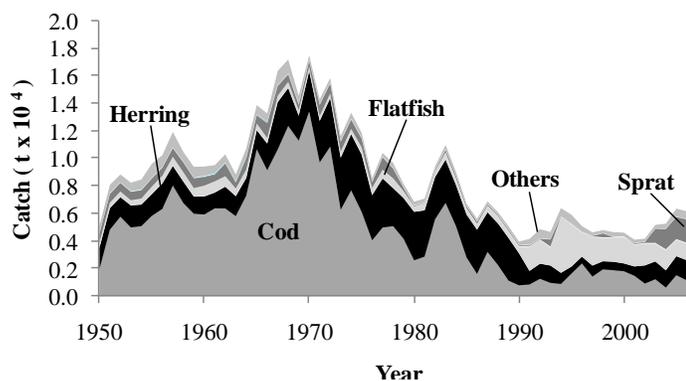


Figure 4. Germany's discards by taxa, 1950-2007.

Table 8. Total discards (tonnes) of commercially targeted species in Germany from 1950-2007.

Common Name	1950-1959	1960-1969	1970-1979	1980-1989	1990-1999	2000-2007
Cod	56,071	86,358	71,918	33,064	14,403	10,111
Herring	15,234	17,890	33,818	31,209	9,257	9,383
Sprat	6,411	6,561	6,192	1,044	1,017	7,651
Flatfishes	4,666	5,601	4,666	4,242	19,033	11,678
Salmon	70	411	137	77	80	46
'Others'	7,557	6,770	3,122	2,176	3,984	2,784

average discards of cod were roughly 11,000 t-year⁻¹ (Figure 4). Cod discards decreased from 1990-2007, but remained high compared to overall cod landings (Appendix Table A2). Herring and sprat discards represented 24% and 6% of the total discards over the study period, respectively. Herring discards peaked in the 1970s and 1980s with an average of over 2,500 t-year⁻¹ (Figure 4) Salmon discards were highest from 1960 to 1972, with an average of 37 t-year⁻¹ and a total of 477 t over that period (Figure 4). Salmon discards were much lower in subsequent years with an average of 8 t-year⁻¹ in the period from 1973-2007. Flatfish discards peaked at over 3,900 t-year⁻¹ in 1994 and remained high throughout the 1990s and 2000s. Discards of 'others' accounted for 26,517 t from 1950-2007, with an average of approximately 450 t-year⁻¹ (Figure 4).

Recreational catches

Here, recreational catches included cod, herring and flatfishes. Cod made up the majority of recreational catches for Germany in the Baltic Sea. Recreational catches in Germany from 1950-2007 totaled 70,740 t (Appendix Table A1). Recreational catches increased from 410 t-year⁻¹ in 1950 to over 3,500 t-year⁻¹ by 2006, with the most significant increase in the early 1990s (Figure 5, Appendix Table A1). With reunification in 1990, recreational fishing in the eastern parts of Germany was permitted and this corresponds to the sharp increase in recreational catches that appears from 1990 onward (Figure 5).

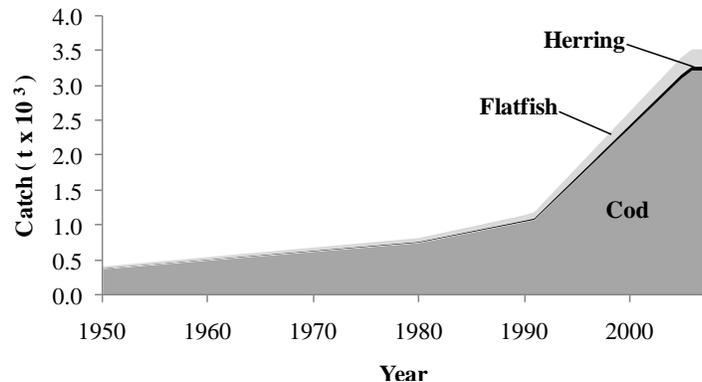


Figure 5. Germany's recreational catches by taxa, 1950-2007.

Overall, cod represents over 91% of the total recreational catch for Germany, with herring and flatfishes making up 2% and 7%, respectively (Figure 5). Recreational catches of cod, herring and flatfishes all increased steadily and substantially over the study period. Recreational catches of cod increased

Table 9. Total recreational catches (tonnes) for Germany

Common name	1950-1959	1960-1969	1970-1979	1980-1989	1990-1999	2000-2007
Cod	4,289	5,532	6,775	8,802	15,929	22,883
Herring	92	118	145	188	362	504
Flatfishes	333	430	526	684	1,318	1,831

from 373 t-year⁻¹ in 1950 to 3,219 t-year⁻¹ in 2007, adding a total of 64,210 t to the reported landings over the 1950-2007 study period. Herring catches in Germany's recreational fisheries increased from 8 t-year⁻¹ in 1950 to 69 t-year⁻¹ in 2007 (Figure 5). Recreational fisheries for flatfish increased from 29 t-year⁻¹ in 1950 to 250 t-year⁻¹ in 2007. From 1950-2007, recreational catches of herring added an additional 1,408 t to reported landings and flatfishes added an extra 5,122 t (Figure 5).

Total reconstructed catch

The total reconstructed catch for Germany included 'adjustments', estimates of unreported landings, discards and recreational catches in addition to the officially reported ICES landings statistics, were estimated to be 5,758,267 t for the period 1950-2007 (Figure 6). Reconstructed catch totals were 36% higher than those presented for Germany in the ICES landings statistics, which were 4,221,739 t during the same time period (Figure 7, Appendix Table A1). This difference is due, in part, to the additional

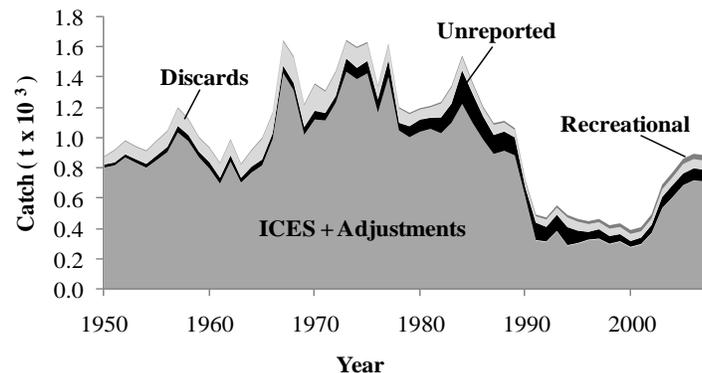


Figure 6. Area graph of Germany's total reconstructed catch by component from 1950-2007.

landings derived from ICES stock assessment working group data and from national sources, which added adjustments of almost 630,000 t to the ICES landings statistics. The other major contributors to the reconstructed catch were the large proportion of unreported landings (Figure 3) and discards (Figure 4), mainly of cod, herring, sprat and flatfishes. Cod represented the greatest proportion of taxa that were unreported (58%) and the greatest proportion discarded (55%) (Appendix Table A1 and A2). Recreational fisheries, also dominated by cod, added another 64,210 t to the total reported landings (Appendix

Table A2). When considering both reported and unreported catch components, cod and herring fisheries dominated throughout the study period, with the highest estimated catches for both these species during the 1970s (Table 10).

Of the total reconstructed catch from 1950-2007, adjustments, unreported landings, discards and recreational catches represented 11%, 6%, 9% and 1%, respectively (Appendix Table A1). Adjustments were most significant in the 1950s, adding over 100% to what was reported in the ICES landings statistics for that decade. Discards were highest in the 1960s unreported landings were greatest in the 1980s. Recreational catches have been increasing since the 1950s with the highest levels in the 2000s (Table 11).

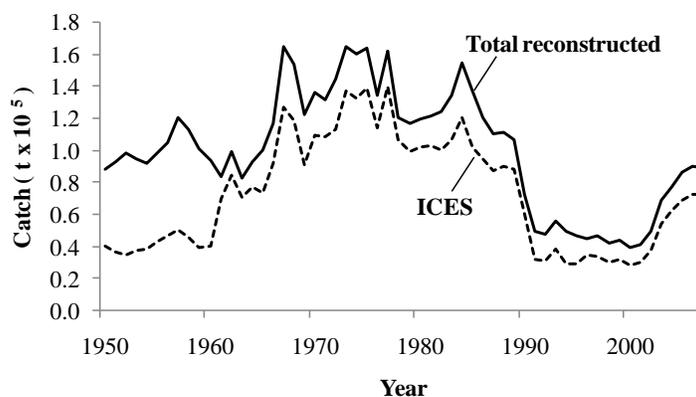


Figure 7. Total reconstructed catch and ICES landings statistics for Germany, 1950-2007.

Table 10. Total reconstructed catch (tonnes) for commercially targeted species in Germany from 1950-2007.

Common name	1950-1959	1960-1969	1970-1979	1980-1989	1990-1999	2000-2007
Cod	364,957	385,208	465,431	435,343	169,917	118,252
Herring	320,000	375,805	710,328	655,567	194,763	197,555
Sprat	134,639	137,778	130,035	21,920	21,359	160,672
Flatfishes	48,603	50,026	45,435	46,470	65,159	40,182
Salmon	645	3,034	1,014	576	580	328
Others ^a	131,002	153,905	70,801	47,061	31,842	22,078

^adetailed taxonomic breakdown of this grouping is available in the electronic data being used by the *Sea Around Us* Project.

Table 11. Total Reconstructed catch (t) by component for all taxa for Germany from 1950-2007.

Component	1950-1959	1960-1969	1970-1979	1980-1989	1990-1999	2000-2007
ICES landings	409,989	844,508	1,201,737	995,492	347,259	422,754
Adjustments	468,280	94,978	35,589	29,455	2,220	-1,913
Unreported	26,855	36,600	58,417	100,505	68,757	51,354
Discards	90,009	123,591	119,854	71,812	47,775	41,654
Recreational	4,714	6,080	7,446	9,673	17,609	25,218

DISCUSSION

Our total reconstructed catch for Germany for the period 1950-2007 was estimated to be approximately 6 million tonnes (t). Separate methodologies were used for estimating catch components for East and West Germany. The estimated reconstructed catch, calculated for each were then combined to represent the total reconstructed catch for Germany. This reconstructed catch total was 36% higher than the amount presented in the ICES landings statistics on behalf of Germany, which was approximately 4.2 million t over the same time period. This difference was due, in part, to the additional landings derived from ICES stock assessment working group data and from national sources, which were considered to be 'adjustments' to landings. These adjustments were mainly to account for the fact that East Germany's landings were not presented in the ICES landings statistics prior to 1961. Additional data concerning cod landings for former East and West Germany were contributed by our German co-author (C. Hammer, unpubl. data). To estimate discards and unreported landings we relied on Baltic-wide rates, which are likely to be conservative.

Besides adjustments, the other major contributors to the reconstructed catch total were discards and unreported landings, mainly of cod. Discards have been identified as a major concern for fisheries

worldwide (Alverson *et al.*, 1994; Kelleher, 2005; Zeller and Pauly, 2005). For fisheries in Germany, we estimated discards to be 9% of the total reconstructed catch with cod representing the greatest proportion of taxa that were discarded (55%). Unreported landings are also a serious concern for fisheries globally and are considered a significant problem in the Baltic Sea (Menn, 2006; Anon., 2007b). Germany's unreported landings were estimated to be 6% of the total reconstructed catch, and cod was the major contributor, representing 58% of all taxa that were unreported.

Our estimates of discards and unreported landings for Germany were mostly based on Baltic-wide estimates, which may be under-estimates. Rates used were derived from Baltic-wide discards or unreported landings (based on ICES stock assessment working group reports) as a proportion of the total Baltic-wide landings. We made corrections for countries that are known to not report their unreported landings (e.g., Sweden). As ICES did not disclose which countries did not report amounts of unreported landings, we could not make all the appropriate adjustments in order to make accurate country-specific estimates of these catch components. If ICES had been more transparent in disclosing country-specific information, the rates would have been higher as we would have subtracted the landings for non-reporting countries from the total Baltic-wide landings, while the amount of unreported landings remained the same. Thus, accounts of unreported landings were likely under-estimates and therefore conservative. While Germany has made some attempts at reducing discards through the use of logbooks and Vessel Monitoring Systems (VMS), these mechanisms have not significantly reduced discarding (Prمود *et al.*, 2008).

Recreational fisheries were only a small contributor to the total reconstructed catch, representing approximately 1%. Recreational fisheries were dominated by cod, which constituted over 90% of Germany's recreational catches. In Germany, cod from the eastern and western stock are caught; however, eastern cod was only considered to have been available recreationally in Germany since reunification in 1990. Prior to 1990, catches of eastern cod were restricted because they were mostly located in East German territory where recreational fishing was illegal, and we considered that West Germans did not have access to this stock. Surveys were conducted in recent years to estimate the amount of cod, herring and flounder caught by recreational anglers in Germany. However, recreational catches are currently not included in stock assessments, which results in under-estimates of TACs (Prمود *et al.*, 2008). In the most recent survey year (2006), recreational catches of cod were a third of the commercial cod catches as presented by ICES landings statistics. To accurately represent the amount of fish being removed from the Baltic Sea, recreational catches must be included in estimations used to allocate catches, particularly for commercially important taxa such as cod.

Cod stocks in the Baltic Sea have been significantly depleted over the past three decades (Menn, 2006). While there are signs of some recovery for the eastern cod stock, populations of both stocks remain low compared to historic levels (Anon., 2006b; Veem *et al.*, 2009). In a study of over 230 fish populations Hutchings and Reynolds (2004) found that rates of recovery were linked to life history characteristics and cod exhibit a much slower rate of recovery, if they recover at all, compared to other taxa such as herring. Even when quotas are severely reduced, recovery of depleted stocks can be threatened by illegal fishing, misreporting and discarding of catches (Hutchings and Reynolds, 2004). Unreported landings of cod are known to be high throughout the Baltic, estimated at 40-60% of reported catches (Anon., 2006b). While cod fisheries in Germany had a lower average rate of unreported landings over the entire time period, unreported landings were in the higher range in some years. The recovery of cod stocks in the Baltic Sea requires immediate action to reduce the amount of unreported cod landings.

Illegal, Unreported and Unregulated (IUU) fishing is a concern for fisheries globally (Bray, 2000; Crona and Österblom, 2009). Our assessment of IUU fishing in Germany since 1950 reveals that there are considerable catches that are not being reported and represented in the publicly available ICES landings statistics database. Germany, among other Baltic countries, is a member of the European Union (EU), and as an EU member state, Germany is subject to the Common Fisheries Policy (CFP), which includes a code of conduct for all EU fisheries. Despite regulations in place to reduce IUU fishing, the CFP has failed to prevent IUU catches by its member states. Unreported landings and discards continue to be a serious concern in the Baltic Sea and unless a revised CFP, due in 2012, is able to implement stricter regulations, fisheries in the Baltic Sea will continue to be threatened by IUU fishing. Revisions to the CFP should include improved data collection, quality and transparency (Lutchman, 2009; Richartz, 2009). In a global assessment of the core features in the management process that determine the sustainability of a fishery, transparency ranked as the most important factor when compared to other factors such as scientific

robustness, implementation and enforcement of regulations, fishing capacity, subsidies and access to foreign fishing (Mora *et al.*, 2009). Currently much of the data needed for effective management of Germany's fisheries are not widely available. Increasing the availability of good quality fisheries data will facilitate better management decisions, encourage public involvement and allow for greater accountability.

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APPENDIX A

Appendix Table A1. ICES landing statistics, adjustments to ICES landing statistics, unreported landings, discards, recreational catch, and reconstructed total for Germany (t).

Year	ICES landing statistics	Adjustments	Un-reported	Dis-cards	Re-creational	Total
1950	40,174	40,204	2,009	5,064	410	87,861
1951	36,290	45,572	1,926	8,060	424	92,272
1952	34,418	52,753	1,923	8,817	437	98,348
1953	37,086	46,516	2,173	8,216	451	94,441
1954	38,054	42,259	2,352	8,441	465	91,571
1955	43,080	42,368	2,796	9,588	478	98,310
1956	46,696	43,995	3,131	10,203	492	104,517
1957	49,899	53,803	3,803	11,867	506	119,878
1958	45,750	52,138	3,588	10,421	519	112,417
1959	38,544	48,668	3,155	9,331	533	100,232
1960	40,003	39,732	3,587	9,334	547	93,203
1961	69,703	18	3,324	9,440	560	83,045
1962	84,375	19	3,530	10,242	574	98,740
1963	70,419	0	2,771	8,792	587	82,569
1964	77,094	0	3,441	10,662	601	91,798
1965	73,606	8,224	3,516	13,847	615	99,808
1966	92,381	6,908	3,436	13,245	628	116,598
1967	127,050	16,076	4,343	16,345	642	164,456
1968	118,492	13,195	4,261	17,178	656	153,782
1969	91,385	10,806	4,391	14,505	669	121,757
1970	109,364	2,999	5,002	17,440	683	135,488
1971	108,646	3,076	4,355	14,244	697	131,017
1972	113,015	10,574	3,850	15,774	710	143,922
1973	137,336	6,769	7,022	11,427	724	163,278
1974	133,030	6,191	5,918	13,138	738	159,014
1975	139,613	3,407	6,665	11,665	751	162,101
1976	114,503	2,534	6,910	8,467	765	133,179
1977	140,288	342	8,550	10,283	779	160,241
1978	106,649	-1,595	4,318	9,541	792	119,704
1979	99,294	1,293	5,829	7,876	806	115,099
1980	102,161	2,049	6,223	6,733	820	117,986
1981	102,929	3,200	6,100	7,005	853	120,086
1982	100,617	2,613	8,103	9,235	885	121,452
1983	107,180	3,103	9,779	10,770	918	131,750
1984	120,321	2,399	16,737	8,767	951	149,175
1985	102,400	7,599	14,319	6,450	984	131,752
1986	94,751	4,179	11,294	5,452	1,017	116,693
1987	87,731	1,689	9,465	6,611	1,049	106,545
1988	89,626	1,918	9,590	5,863	1,082	108,079
1989	87,777	706	8,894	4,927	1,115	103,419
1990	60,326	529	4,994	3,850	1,148	70,847
1991	31,500	806	9,111	3,958	1,192	46,567
1992	30,931	452	7,945	4,674	1,351	45,354
1993	38,210	193	9,044	4,497	1,510	53,455
1994	28,905	-9	10,596	6,194	1,670	47,356
1995	29,097	1,258	7,676	5,781	1,829	45,641
1996	33,846	-1,249	4,576	4,996	1,988	44,157
1997	33,043	230	5,667	4,530	2,148	45,617
1998	29,861	5	4,717	4,715	2,307	41,605
1999	31,541	5	4,429	4,579	2,466	43,021
2000	27,782	18	3,676	4,546	2,626	38,648
2001	29,688	1	4,080	4,046	2,785	40,599
2002	37,045	-1	5,080	4,122	2,944	49,190
2003	53,530	5	7,111	5,129	3,104	68,879
2004	61,955	-1,097	8,005	5,231	3,263	77,357
2005	68,749	-5	7,749	6,324	3,422	86,240
2006	71,965	-17	7,945	6,128	3,537	89,558
2007	72,040	-817	7,708	6,127	3,537	88,596

Appendix Table A2. ICES landing statistics, adjustments to ICES landing statistics, unreported landings, discards, recreational catch, and reconstructed total for cod (*Gadus morhua*) for Germany (t).

Year	ICES landing statistics	Adjustments	Un-reported	Dis-cards	Re-creational	Total
1950	13,151	10,741	658	2,001	373	26,923
1951	8,771	16,109	495	4,893	385	30,653
1952	10,080	23,290	633	5,830	398	40,230
1953	9,181	17,053	637	5,049	410	32,331
1954	9,623	12,796	730	5,145	423	28,716
1955	10,981	12,905	902	5,890	435	31,113
1956	11,644	14,532	1,028	6,390	448	34,042
1957	18,690	24,340	1,868	8,060	460	53,417
1958	15,364	22,675	1,643	6,795	472	46,949
1959	13,356	19,205	1,518	6,019	485	40,582
1960	15,867	10,269	1,963	5,943	497	34,539
1961	22,137	0	1,912	6,400	510	30,959
1962	19,897	1	1,643	6,403	522	28,466
1963	17,847	0	1,314	5,857	535	25,552
1964	18,197	0	1,801	7,339	547	27,883
1965	17,989	8,224	2,069	10,724	559	39,566
1966	16,512	6,908	1,756	9,207	572	34,955
1967	18,909	16,059	1,956	10,723	584	48,231
1968	28,186	13,125	2,500	12,437	597	56,845
1969	32,666	10,745	2,867	11,325	609	58,211
1970	34,600	2,943	3,285	13,428	622	54,878
1971	24,149	3,076	2,743	9,752	634	40,353
1972	25,351	3,885	2,752	10,869	646	43,504
1973	36,349	6,765	6,020	6,175	659	55,967
1974	29,114	4,086	4,836	7,593	671	46,300
1975	36,223	3,399	5,471	6,019	684	51,796
1976	32,644	2,534	6,124	4,050	696	46,048
1977	42,527	-754	7,618	4,971	709	55,070
1978	26,263	-1,796	3,325	5,055	721	33,568
1979	27,080	1,292	4,836	4,006	733	37,947
1980	23,769	2,044	4,991	2,582	746	34,132
1981	28,020	3,197	4,788	2,899	776	39,680
1982	30,615	2,613	6,819	5,490	806	46,343
1983	32,572	3,103	8,372	6,667	835	51,550
1984	49,518	2,399	15,427	4,929	865	73,138
1985	30,792	7,599	12,846	2,650	895	54,781
1986	21,422	4,179	9,720	1,569	925	37,815
1987	22,241	1,689	8,279	3,054	955	36,218
1988	21,022	1,907	8,438	2,135	985	34,486
1989	16,784	705	7,607	1,091	1,014	27,201
1990	8,855	520	3,666	797	1,044	14,882
1991	8,637	806	4,835	846	1,074	16,198
1992	6,668	-219	3,083	1,284	1,219	12,035
1993	5,127	-1	2,290	1,010	1,364	9,790
1994	7,088	-9	4,728	922	1,509	14,238
1995	14,681	11	3,699	1,698	1,654	21,743
1996	20,607	-1,249	1,397	2,428	1,799	24,982
1997	14,483	1	1,436	1,475	1,944	19,338
1998	10,989	3	748	2,004	2,089	15,833
1999	15,439	0	1,266	1,940	2,234	20,879
2000	13,079	1	1,006	1,868	2,379	18,333
2001	12,738	0	1,243	1,540	2,524	18,045
2002	8,768	-1	775	976	2,669	13,186
2003	8,125	4	882	1,289	2,813	13,113
2004	8,407	-1,097	1,410	686	2,958	12,364
2005	9,346	-5	1,089	1,580	3,103	15,113
2006	9,558	-17	953	1,208	3,219	14,920
2007	9,148	-817	663	964	3,219	13,177

Appendix Table A3. ICES landing statistics, adjustments to ICES landing statistics, unreported landings, discards, recreational catch, and reconstructed total for herring (*Clupea harengus*) for Germany (t).

Year	ICES landing statistics	Adjustments	Un-reported	Dis-cards	Re-creational	Total
1950	20,777	9,156	1,039	1,549	8	32,528
1951	20,755	9,156	1,079	1,550	8	32,548
1952	18,107	9,156	960	1,411	8	29,642
1953	21,416	9,156	1,178	1,587	9	33,346
1954	20,713	9,156	1,181	1,552	9	32,611
1955	20,888	9,156	1,232	1,564	9	32,850
1956	25,928	9,156	1,556	1,832	10	38,481
1957	18,026	9,156	1,118	1,415	10	29,724
1958	20,439	9,156	1,308	1,545	10	32,458
1959	14,475	9,156	941	1,229	10	25,811
1960	15,794	9,156	1,058	1,300	11	27,319
1961	21,641	0	976	1,131	11	23,758
1962	29,825	0	1,472	1,565	11	32,873
1963	27,458	0	1,194	1,433	11	30,096
1964	24,063	0	1,210	1,264	12	26,549
1965	26,204	0	1,130	1,367	12	28,713
1966	36,873	0	1,405	1,914	12	40,205
1967	66,413	0	1,860	3,414	12	71,699
1968	53,141	0	1,326	2,723	13	57,203
1969	34,343	0	1,255	1,780	13	37,391
1970	56,417	0	1,545	2,898	13	60,873
1971	58,318	0	1,420	2,987	14	62,738
1972	68,813	0	950	3,488	14	73,265
1973	74,384	0	781	3,758	14	78,938
1974	80,301	0	860	4,058	14	85,233
1975	81,873	0	944	4,141	15	86,972
1976	64,650	0	624	3,264	15	68,553
1977	70,110	0	735	3,542	15	74,403
1978	54,069	0	765	2,742	15	57,591
1979	58,027	0	779	2,940	16	61,762
1980	69,060	0	997	3,503	16	73,576
1981	65,767	0	995	3,338	17	70,116
1982	59,796	0	1,045	3,042	17	63,900
1983	61,264	0	1,159	3,121	18	65,562
1984	58,239	0	1,086	2,966	18	62,310
1985	60,686	0	1,271	3,098	19	65,074
1986	62,443	0	1,389	3,192	20	67,043
1987	56,236	0	967	2,860	20	60,084
1988	59,238	0	935	3,009	21	63,202
1989	60,605	0	994	3,080	22	64,700
1990	45,339	0	922	2,313	22	48,597
1991	16,022	0	2,996	951	25	19,994
1992	17,746	0	3,460	1,060	28	22,295
1993	20,143	0	4,089	1,212	32	25,475
1994	12,367	0	3,327	785	35	16,513
1995	7,898	0	2,006	495	38	10,437
1996	7,737	0	1,857	480	41	10,114
1997	12,755	0	2,870	781	44	16,450
1998	9,514	0	1,998	576	47	12,135
1999	10,115	0	1,983	605	50	12,753
2000	9,475	0	1,715	559	53	11,803
2001	11,447	0	1,912	668	56	14,083
2002	22,661	0	3,444	1,305	59	27,470
2003	22,637	0	3,101	1,287	63	27,088
2004	22,244	0	2,736	1,249	66	26,295
2005	24,754	0	2,772	1,376	69	28,972
2006	26,206	0	2,935	1,457	69	30,667
2007	26,644	0	2,984	1,481	69	31,178

Appendix Table A4. ICES landing statistics, adjustments to ICES landing statistics, unreported landings, discards, recreational catch, and reconstructed total for sprat (*Sprattus sprattus*) for Germany (t).

Year	ICES landing statistics	Adjustments	Un-reported	Dis-cards	Re-creational	Total
1950	1,636	11,568	82	664	0	13,950
1951	1,091	11,568	57	636	0	13,351
1952	1,071	11,568	57	635	0	13,330
1953	778	11,568	43	619	0	13,008
1954	532	11,568	30	606	0	12,736
1955	301	11,568	18	594	0	12,481
1956	196	11,568	12	589	0	12,364
1957	1,006	11,568	62	632	0	13,268
1958	2,610	11,568	167	717	0	15,062
1959	2,632	11,568	171	719	0	15,089
1960	892	11,568	60	626	0	13,145
1961	9,450	0	43	475	0	9,967
1962	18,465	0	42	925	0	19,432
1963	8,499	0	37	427	0	8,962
1964	16,239	0	117	818	0	17,173
1965	11,685	0	39	586	0	12,311
1966	21,540	0	28	1,078	0	22,647
1967	13,916	0	231	707	0	14,855
1968	10,612	0	85	535	0	11,232
1969	7,639	0	31	384	0	8,054
1970	8,134	0	14	407	0	8,555
1971	16,237	0	10	812	0	17,059
1972	14,346	0	26	719	0	15,091
1973	14,151	0	102	713	0	14,966
1974	13,370	0	79	672	0	14,121
1975	12,420	0	54	624	0	13,098
1976	7,942	0	43	399	0	8,384
1977	17,954	0	68	901	0	18,924
1978	14,280	0	56	717	0	15,053
1979	4,508	0	49	228	0	4,785
1980	857	0	71	46	0	975
1981	583	0	55	32	0	670
1982	1,667	0	68	87	0	1,822
1983	3,243	0	69	166	0	3,477
1984	3,404	0	85	174	0	3,664
1985	2,588	0	89	134	0	2,811
1986	2,906	0	58	148	0	3,112
1987	1,700	0	61	88	0	1,849
1988	1,488	0	42	76	0	1,606
1989	1,742	0	99	92	0	1,933
1990	1,423	0	162	79	0	1,664
1991	736	0	138	44	0	917
1992	608	0	119	36	0	763
1993	8,267	0	1,678	497	0	10,442
1994	374	0	101	24	0	498
1995	230	0	58	14	0	303
1996	161	0	39	10	0	210
1997	428	0	96	26	0	551
1998	4,551	0	956	275	0	5,782
1999	182	0	36	11	0	229
2000	22	0	4	1	0	27
2001	792	0	132	46	0	970
2002	950	0	144	55	0	1,149
2003	18,023	0	2,469	1,025	0	21,517
2004	26,354	0	3,242	1,480	0	31,075
2005	28,975	0	3,245	1,611	0	33,831
2006	30,779	0	3,447	1,711	0	35,938
2007	30,973	0	3,469	1,722	0	36,164

Appendix Table A5. ICES landing statistics, adjustments to ICES landing statistics, unreported landings, discards, recreational catch, and reconstructed total for salmon (*Salmo salar*) for Germany (t).

Year	ICES landing statistics	Adjustments	Un-reported	Dis-cards	Re-creational	Total
1950	0	18	0	1	0	19
1951	142	18	8	25	0	192
1952	7	18	0	2	0	27
1953	82	18	5	15	0	120
1954	117	18	8	21	0	164
1955	0	18	0	1	0	18
1956	4	18	0	1	0	23
1957	7	18	1	2	0	27
1958	7	18	1	2	0	27
1959	7	18	1	2	0	27
1960	226	18	23	41	0	307
1961	359	18	38	64	0	479
1962	222	18	24	40	0	304
1963	190	0	21	33	0	245
1964	325	0	36	55	0	415
1965	238	0	29	42	0	309
1966	203	0	26	37	0	266
1967	186	0	25	34	0	245
1968	214	0	30	39	0	283
1969	136	0	20	25	0	181
1970	152	0	23	28	0	203
1971	97	0	15	18	0	130
1972	107	1	17	20	0	145
1973	100	0	16	19	0	135
1974	78	0	11	11	0	100
1975	71	0	12	13	0	96
1976	59	0	10	11	0	80
1977	38	0	7	7	0	52
1978	19	0	3	3	0	26
1979	34	0	6	6	0	47
1980	48	0	9	9	0	67
1981	22	0	4	4	0	30
1982	17	0	3	3	0	23
1983	23	0	5	4	0	32
1984	35	0	7	6	0	48
1985	35	0	7	6	0	47
1986	64	0	14	13	0	90
1987	36	0	7	7	0	50
1988	56	0	12	11	0	79
1989	80	0	14	14	0	108
1990	57	0	13	13	0	83
1991	87	0	17	16	0	120
1992	56	0	11	11	0	78
1993	55	0	11	10	0	76
1994	13	0	2	2	0	18
1995	13	0	3	2	0	18
1996	28	0	6	6	0	39
1997	35	0	7	7	0	49
1998	42	0	8	8	0	58
1999	29	0	6	6	0	41
2000	44	0	9	6	0	59
2001	38	0	8	8	0	53
2002	29	0	6	6	0	41
2003	29	0	6	6	0	41
2004	35	0	7	7	0	50
2005	24	0	5	5	0	34
2006	18	0	4	4	0	26
2007	17	0	4	3	0	24

Appendix Table A6. ICES landing statistics, adjustments to ICES landing statistics, unreported landings, discards, recreational catch, and reconstructed total for the category 'flatfish' for Germany (t).

Year	ICES landing statistics	Adjustments	Un-reported	Dis-cards	Re-creational	Total
1950	433	3,560	22	316	29	4,359
1951	513	3,560	27	352	30	4,481
1952	561	3,560	30	370	31	4,551
1953	473	3,560	26	327	32	4,418
1954	630	3,560	36	390	33	4,648
1955	894	3,560	53	510	34	5,050
1956	896	3,560	54	530	35	5,075
1957	1,100	3,560	68	643	36	5,407
1958	1,095	3,560	70	650	37	5,412
1959	965	3,560	63	578	38	5,203
1960	1,344	3,560	90	740	39	5,773
1961	4,849	0	104	776	40	5,769
1962	4,746	0	94	725	41	5,606
1963	4,713	0	57	516	42	5,328
1964	5,537	0	67	585	42	6,231
1965	3,130	0	68	488	43	3,730
1966	3,507	0	50	397	44	3,999
1967	4,162	17	62	481	45	4,767
1968	4,378	70	62	485	46	5,042
1969	3,210	61	57	407	47	3,782
1970	2,863	56	51	365	48	3,383
1971	3,081	0	48	355	49	3,532
1972	3,743	112	48	379	50	4,332
1973	4,075	4	58	434	51	4,622
1974	3,019	0	57	381	52	3,509
1975	3,110	8	87	517	53	3,775
1976	3,637	0	79	489	54	4,260
1977	4,339	1,096	92	607	55	6,189
1978	5,142	201	109	672	56	6,179
1979	5,062	1	67	466	57	5,653
1980	3,747	5	47	337	58	4,193
1981	3,736	3	77	449	60	4,325
1982	4,152	0	64	389	63	4,667
1983	4,709	0	94	518	65	5,386
1984	3,836	0	88	448	67	4,439
1985	4,833	0	76	413	70	5,391
1986	3,974	0	73	355	72	4,474
1987	3,214	0	118	427	74	3,833
1988	3,987	11	125	466	76	4,664
1989	4,467	1	111	440	79	5,097
1990	2,543	9	149	450	81	3,232
1991	3,055	0	571	1,681	92	5,400
1992	2,287	671	577	1,637	104	5,276
1993	2,157	194	477	1,263	115	4,206
1994	6,635	0	1,785	3,903	126	12,449
1995	5,146	1,247	1,624	3,062	137	11,217
1996	3,135	0	752	1,665	149	5,701
1997	3,312	229	797	2,015	160	6,512
1998	2,955	2	621	1,648	171	5,397
1999	3,239	5	636	1,708	182	5,770
2000	3,475	17	632	1,838	194	6,156
2001	2,919	1	488	1,525	205	5,138
2002	3,011	0	458	1,559	216	5,243
2003	2,614	1	358	1,272	227	4,473
2004	3,082	0	379	1,452	239	5,152
2005	2,489	0	279	1,176	250	4,194
2006	2,541	0	285	1,196	250	4,271
2007	3,277	0	367	1,660	250	5,554

Appendix Table A7. ICES landing statistics, adjustments to ICES landing statistics, unreported landings, discards, recreational catch, and reconstructed total for the category 'others' for Germany (t).

Year	ICES landing statistics	Adjustments	Un-reported	Dis-cards	Re-creational	Total
1950	4,177	5,162	209	535	0	10,082
1951	5,018	5,162	261	605	0	11,046
1952	4,592	5,162	243	570	0	10,568
1953	5,155	5,162	284	618	0	11,219
1954	6,439	5,162	367	727	0	12,695
1955	10,017	5,162	591	1,029	0	16,799
1956	8,028	5,162	482	860	0	14,531
1957	11,070	5,162	686	1,116	0	18,034
1958	6,235	5,162	399	712	0	12,508
1959	7,109	5,162	462	786	0	13,519
1960	5,880	5,162	394	684	0	12,120
1961	11,267	0	253	594	0	12,114
1962	11,220	0	255	584	0	12,059
1963	11,712	0	147	526	0	12,385
1964	12,733	0	210	603	0	13,546
1965	14,361	0	180	640	0	15,180
1966	13,746	0	170	611	0	14,527
1967	23,464	0	209	986	0	24,658
1968	21,961	0	258	958	0	23,177
1969	13,391	0	163	585	0	14,139
1970	7,199	0	84	312	0	7,595
1971	6,764	0	120	320	0	7,204
1972	655	6,576	58	298	0	7,586
1973	8,277	0	43	329	0	8,650
1974	7,148	2,105	76	422	0	9,751
1975	5,917	0	97	351	0	6,364
1976	5,571	0	29	254	0	5,854
1977	5,320	0	29	254	0	5,604
1978	6,876	0	60	352	0	7,287
1979	4,583	0	93	230	0	4,905
1980	4,680	0	108	256	0	5,043
1981	4,801	0	181	283	0	5,265
1982	4,370	0	104	224	0	4,698
1983	5,368	0	80	294	0	5,743
1984	5,289	0	44	243	0	5,576
1985	3,466	0	31	150	0	3,646
1986	3,942	0	41	175	0	4,158
1987	4,305	0	33	175	0	4,512
1988	3,835	0	39	166	0	4,041
1989	4,100	0	69	210	0	4,379
1990	2,109	0	83	197	0	2,389
1991	2,963	0	554	421	0	3,938
1992	3,566	0	695	646	0	4,908
1993	2,462	0	500	505	0	3,467
1994	2,428	0	653	559	0	3,640
1995	1,129	0	287	508	0	1,923
1996	2,178	0	525	407	0	3,110
1997	2,030	0	460	225	0	2,716
1998	1,810	0	385	205	0	2,400
1999	2,537	0	504	310	0	3,351
2000	1,687	0	309	273	0	2,269
2001	1,754	0	297	258	0	2,309
2002	1,626	0	252	221	0	2,100
2003	2,102	0	295	251	0	2,648
2004	1,833	0	231	358	0	2,422
2005	3,161	0	359	576	0	4,096
2006	2,863	0	321	552	0	3,735
2007	1,981	0	222	296	0	2,499

CATCH RECONSTRUCTION FOR LATVIA IN THE BALTIC SEA FROM 1950–2007¹

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ABSTRACT

Total marine fisheries catches by Latvia in the Baltic Sea (or its equivalent entity prior to separation from the USSR in 1991) were estimated from 1950–2007 using an approach called ‘catch reconstruction’. ICES landing statistics (which only report commercial landings) formed the baseline of the reconstruction, to which we added ‘adjustments to ICES landing statistics’ (particularly disaggregated data from when Latvia was part of the USSR), estimates of unreported landings, estimates of discards, and estimates of recreational catches. The reconstructed catch from 1950–2007 is approximately 4.7 million tonnes, attributing an additional 3.5 million tonnes to Latvia above catches reported by ICES for independent Latvia. From 1991–2007 when ICES landing statistics were reported for Latvia independently, our reconstructed catch was 28% higher than their reported 1.2 million tonnes. The most commercially important species are herring (*Clupea harengus*), sprat (*Sprattus sprattus*), and cod (*Gadus morhua*). We believe that this reconstruction represents a conservative estimate.

INTRODUCTION

Latvia is on the eastern edge of the Baltic Sea, located between Estonia and Lithuania, and is bordered on the east by Russia and Belarus (Figure 1). Latvia declared its independence from the USSR in 1991, and joined NATO and the European Union in 2004. In 2007, the estimated Latvian population was 2,292,000 (UN, 2008). Latvia has an area of 64,589 km² with a 12 nautical mile territorial limit in the Baltic Sea, although Latvian fishers have access to areas beyond this boundary (FAO, 2009). The main species caught are herring (*Clupea harengus*), sprat (*Sprattus sprattus*), and Atlantic cod (*Gadus morhua*).

Latvia’s fisheries can be divided into four sectors: 1) a Baltic Sea and Gulf of Riga fleet; 2) coastal vessels; 3) a high seas fleet; and 4) inland waters.

1) In 2006, there were 115 trawlers and 48 gillnet vessels fishing in the Baltic Sea and

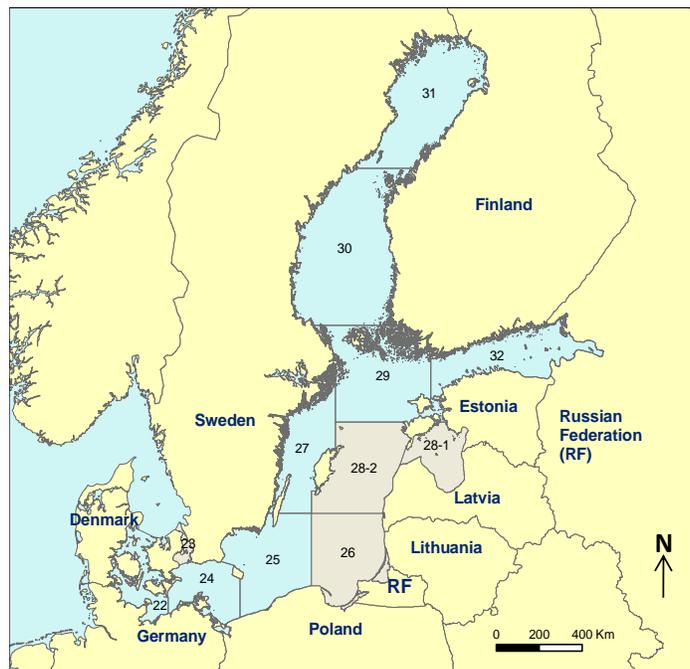


Figure 1. Map of the Baltic Sea with ICES subdivisions and surrounding countries. Latvia’s coastline borders ICES subdivisions 26, 28-1 and 28-2.

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