

## BALTIC SEA FISHERIES CATCHES FOR FINLAND (1950-2007)<sup>1</sup>

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### ABSTRACT

This study estimates total marine and brackish-water catches made by Finland in the Baltic Sea from 1950-2007. We used ICES electronic database landing statistics as the officially-reported data baseline, and then added 'adjustments' to reported landings (from various sources including the Finnish Game and Fisheries Research Institute) as well as estimates of unreported landings, discards, and recreational catches. The total of these components represents reconstructed total catches and provides a more comprehensive view of the total exploitation of marine resources. We believe these estimates are underestimates due to our conservative estimation procedures. ICES landing statistics report 4.5 million tonnes of marine landings from 1950-2007, our reconstruction estimates the total catch to be 29% higher (5.8 million tonnes). The majority of this discrepancy is due to unreported landings and discarding of herring (*Clupea harengus*), while cod (*Gadus morhua*) catches are low compared to other Baltic countries. Finland has recorded recreational fishing since 1953, although it is not known whether they submit estimates of unreported landings or discards (other than seal-induced discards). In an effort to contribute to better management of Baltic fish stocks and the Baltic Sea ecosystem, Finland could allocate more resources towards decreasing the amount of unreported catches and discards.

### INTRODUCTION

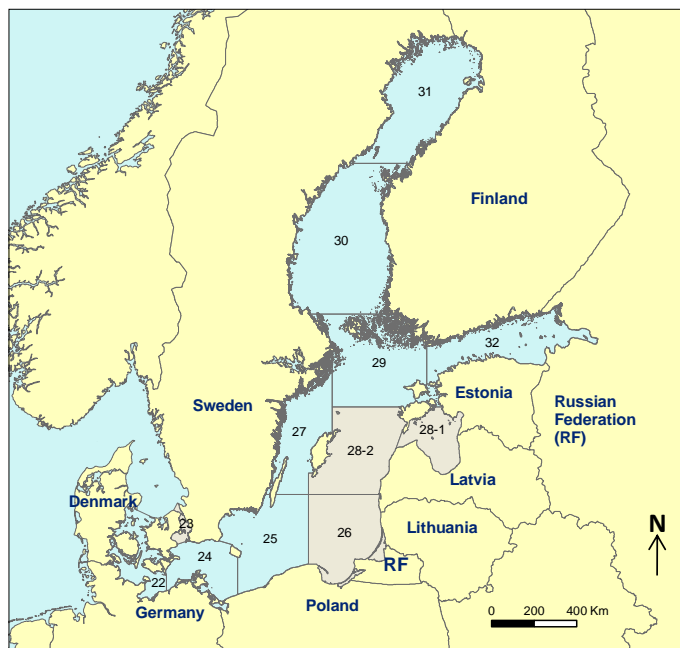
The Nordic Republic of Finland has borders with Sweden, Russia and Norway, and with Estonia to the south across the Gulf of Finland (Figure 1). With a population of 5,329,000 and an area of 302,348 km<sup>2</sup> (Anon., 2009), Finland is the third least densely populated country in the European Union after Norway and Iceland. Finland entered into a free trade agreement with the European Community (EC) in 1973, before experiencing a significant economic recession in the early 1990s. Finland joined the European Union (EU) in 1995, however, and has since developed into a highly-industrialized free-market economy (Melender and Repo, 2006).

Finnish fisheries can be divided into five main sectors: 1) commercial marine; 2) commercial inland; 3) recreational or subsistence in both inshore marine and inland lakes; 4) small-scale marine; and 5) aquaculture. The recreational fishing sector is relatively more important in Finland than in other Scandinavian countries as about half of marine landings are accounted for by recreational fishers, when herring catches are excluded (FAO, 2005). Aquaculture also supplies a substantial portion of fish for human consumption, particularly since the late 1980s when the quality of the Baltic environment and many fish stocks began to decline (Setälä *et al.*, 1998). Our paper, however, will address only wild fisheries catches taken in marine and brackish-water.

**Table 1.** Percent distribution (%) of Finland's reported landings by ICES subdivision, by decade. Prior to the 1980s all landings were reported from ICES division IIIId.

Percentage of catch	1980s	1990s	2000s
ICES subdivision 24	<0.1	0.2	0.39
ICES subdivision 25	<0.1	1.4	2.0
ICES subdivision 26	0.1	0.7	1.1
ICES subdivision 27	0.1	0.4	0.5
ICES subdivision 28	0.7	1.1	0.9
ICES subdivision 29	12.2	24.5	18.5
ICES subdivision 30	8.9	52.3	57.9
ICES subdivision 31	2.6	7.4	5.0
ICES subdivision 32	6.3	12.0	13.8

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**Figure 1.** Map of the Baltic Sea with ICES subdivisions and surrounding countries. Finland's coastline borders ICES subdivisions 29-32.

Despite a high rate of fish consumption in Finland, marine fisheries have never contributed significantly to the economy. In 2000, the industry accounted for approximately 0.1% of the GDP (FAO, 2005). The bulk of fish for human consumption are usually imported from Norway, Denmark, Iceland or Sweden (Setälä *et al.*, 1998). Finnish catches are used mainly for industrial purposes, and as a result, the processing sector in Finland is substantial. In 2001, 1,265 people were employed by some 228 plants processing 35,000 tonnes of fish (FAO, 2005). Small-scale fisheries account for 65% of those employed by fisheries, and consequently are more important in economic terms than vessels acquiring the greatest volumes of catches offshore. Small-scale fisheries are especially important in sparsely populated areas where there are few alternative opportunities for employment (FGFRI, 2009).

The three main species caught by Finland according to landings reported by the International Council for the Exploration of the Sea (ICES), are herring (*Clupea harengus*), sprat (*Sprattus sprattus*) and cod (*Gadus morhua*). The majority are caught by pelagic trawlers less than 24 meters long (a fleet of about 65 vessels in 2002). Herring and sprat landings account for approximately 90% of the total Finnish reported landings, and the majority of herring are usually caught during the spring spawning period (May-June). There are no significant fisheries targeting cod, and the majority of this species is caught as bycatch in herring trawls (~60%), in mixed fisheries operating with gillnets, or as bycatch on salmon (*Salmo salar*) longlines (Sjöblom and Parmanne, 1975). Some herring and sprat are frozen or filleted for human consumption, but about 80% of the total catch is sold as fishmeal to the fur farming industry (FAO, 2005). Annual catches are highly dependent on consumer demands for these products, as in the late 1980s, when animal welfare awareness was on the rise, herring landings experienced a significant depression.

A fleet of trawlers greater than 24 meters in length (about 21 vessels in 2002) catch a higher quality and more diversified catch for human consumption (as compared to pelagic trawlers <24m targeting herring for industry [see above]). Targeted species include herring, sprat, salmon, whitefish (*Coregonus lavaretus*), smelt (*Osmerus eperlanus*) and cod. Salmon are also caught by gill- and trap-net, but increasing damage to trap-nets in traditional sites have caused a significant decrease in their use. Approximately 35% of the commercial salmon catch in 2004 had to be discarded due to seal damage (ICES, 1995). Some flounder (*Platichthys flesus*) is also targeted by gill-net (ICES, 1993). Small-scale fisheries target mainly non-quota species, the most important being whitefish.

Prior to the 1990s, herring were mainly caught by trap-net, but by 2004, the fraction obtained by commercial trawl had increased to 90% (Rahikainen *et al.*, 2004). The most important trawling sites in Finland are the southern and southwestern coasts, as the majority of Finland's catches are reported in ICES subdivisions 29, 30 and 32 (Figure 1; Table 1). Trap netting sites are more evenly distributed along the coast, with some concentration in the Archipelago Sea (subdivision 29; Sjöblom and Parmanne, 1975). More than 50% of Finland's total landings have been reported in subdivision 30 (the Bothnian Sea) since the early 1990s (Table 1).

In early periods of reporting, landings were recorded by ICES divisions IIIb, IIIc and IIId. Division IIIb represents the Sound, IIIc the Belt Sea (located between the Kattegat and Baltic Sea [collectively known as the transition zone]), and IIId the Baltic Sea (Table 2). These divisions were segregated into subdivisions by ICES in the late 1970s (ICES, 1987). In Finland, all reporting prior to the 1980s occurred in ICES

division IIId, which was followed by reporting in the corresponding subdivisions (24-32) beginning in the 1980s (Table 1; Table 2).

Fisheries management in Finland has traditionally been the responsibility of the Ministry of Agriculture and Forestry, Department of Fish and Game. Before joining the EU, Finland had the most centralized fisheries management system of any Nordic country. Commercial and recreational fishers were marginally represented in management agencies and rarely involved in governmental decisions (Jentoft and McCay, 1995). This changed slightly when Finland joined the EU in 1995, as the overarching principles of the Common Fisheries Policy (CFP) became the basis of fisheries governance. Though structural and market-oriented activities are set by this policy, there is some subjectivity as to how the Department of Fish and Game can interpret EU rules [e.g., at what time of year to enforce particular closures (FAO, 2005)]. Total Allowable Catches (TACs) are key elements of management in Finland, and reflect advice from ICES. The five key species in Finland subject to TACs are herring, salmon, sprat, cod, and plaice (FAO, 2005).

**Table 2.** ICES divisions and corresponding subdivisions representing the Danish Sound, Belt and Baltic Sea. Source: (ICES, 1987).

ICES Division	ICES Subdivision
IIId- Sound	23
IIId- Belt Sea	22
IIId- Baltic Sea	24-32

National and EU authorities mainly govern offshore waters and marine reserves, while coastal waters (a distance of 500m from the 2m depth line) are privately owned and managed. The Fishery Act requires stakeholders to design management plans for the fisheries in their area of water, including aspects on utilization, conservation and restoration. Owners form associations which collect revenue from license sales which are invested in management. All privately owned waters are also part of nationally administrated fisheries regions which provide opportunity for cooperation between owners and commercial fishers. Commercial fishers are heavily dependent on access to private waters and these associations address issues of minimum mesh and fish landing sizes as well as temporal closures. Recent developments and urbanization have fragmented private waters triggering complications in management which has initiated requests for re-evaluation of protocol.

On a larger scale, Finland shares many of the management challenges with other EU countries whose resource policies now fall under the CFP. Fishing fleet overcapacity is estimated to be 60% in the EU, and Finland struggles to balance the size and capacity of its fleet with available resources (FAO, 2005). In 2004, the offshore fleet was reduced from 47 to 16 vessels (ICES, 2005b).

The purpose of the present study is to provide an estimate of total fisheries catches in the Baltic Sea by Finland (1950-2007) and contrast these total catches with officially reported data. The ICES catch statistics database offers time series data on marine fisheries landings for this time period, but there has been no apparent effort to fully represent total catches (including Illegal, Unreported and Unallocated catches [IUU]) in contrast to landings. Therefore, for the purposes of our study, the ICES electronic database will be referred to as the 'ICES landings statistics', to better reflect the nature of the data presented, and represents the officially reported data. Sources of IUU include data source adjustments to reported landings data, unreported landings, discards, and recreational catches. Our approach utilizes data by the Finnish Game and Fisheries Research Institute (FGRI), a review of the academic and grey literature, as well as correspondence with local fishers and authorities.

## METHODS

Reported landings extracted from the ICES landings statistics database (ICES, 2009) were used as the reported data baseline for our reconstruction of Finland's total catches in the Baltic Sea from 1950-2007. ICES landings statistics were used as the reported data foundation as they are the only publicly available data that present all countries' landings for all taxa and years (since 1950) in all areas of the Baltic Sea.

All catches that are not included in the ICES landings statistics were considered part of IUU. Here, IUU catches were considered in four components: a) '*adjustments*' to ICES landings statistics based on time series data from reliable sources (e.g., ICES stock assessment working group data, national government agencies); b) '*unreported*' landings (referred to as 'unallocated' catches by ICES); c) '*discards*' being catches or mortality caused by fishing but where fish are not landed or utilized; and d) '*recreational*' catches. The sum of these components plus the officially reported ICES landings statistics provided our total reconstructed catch for Finland from 1950-2007.

Using all available data and information, anchor points were derived or formed through an assumption-based approach (see ‘Methods’ in Zeller *et al.*, this volume). From these anchor points, a complete time series of data from 1950-2007 was constructed using linear interpolations and extrapolations for years when data were not available.

Here, our reconstruction presents the main commercially targeted species for Finland including cod (*Gadus morhua*); herring (*Clupea harengus*); sprat (*Sprattus sprattus*); salmon (*Salmo salar*); a flatfish grouping, which included plaice (*Pleuronectes platessus*), European flounder (*Platichthys flesus*), and turbot (*Psetta maxima*); and an additional 18 individual taxa grouped here for reporting as ‘others’.

### *Illegal, Unreported and Unregulated (IUU) catches*

Illegal, Unreported and Unregulated (IUU) catches are a major source of underreporting in many country’s fisheries catches (Zeller and Pauly, 2007) and are also of concern in the Baltic Sea (Menn, 2006; Anon., 2007b; Crona and Österblom, 2009). Below, we present the methods and data sources used to estimate the four IUU components defined above: a) ‘adjustments’; b) ‘unreported’ landings; c) ‘discards’; and d) ‘recreational’ catches.

Estimates of IUU catch components were based on information obtained through a range of primary and secondary sources. Information was primarily obtained through interviews and collaborations with fisheries experts at the Finnish Game and Fisheries Research Institute (FGFRI) who provided national fisheries catches (commercial landings and recreational catches; A. Ahvonen and P. Söderkultalahti, pers. comm., FGFRI), although we also searched sources such as the European Union’s Directorate-General for Maritime Affairs, the ICES library, and the archives of Finnish newspapers, magazines and fisheries-related organizations.

### Adjustments to ICES landings statistics

The reported ICES landings statistics were adjusted using Finnish landings data provided by FGFRI for the period from 1953-2007, for most taxa including cod, herring, sprat, salmon, flatfishes and ‘others’. For some species in our group flatfishes and ‘others’, FGFRI data were available for slightly different periods of time (Table 3). Landings reported by FGFRI were considered more reliable than the ICES landings statistics for two reasons. Firstly, Finland is unique among the Baltic countries in that recreational catches have been estimated and reported nationally since the late 1950s. Secondly, Finland updated its national catch estimation methods in 1988, which led to a revision of reported landings for Finland from 1980-1986 (Ahvonen, 2001); yet, the ICES landings statistics database was not amended retroactively to account for these updated landings estimates (E. Aro, pers. comm., FGFRI). Thus, negative adjustments to ICES landings statistics were made to account for the inclusion of recreational catches and also to account for the new catch estimation methods by Finland. These adjustments made to ICES landings statistics to account for the inclusion of Finland’s recreational catches made Finland’s landings data comparable to all other Baltic countries by reflecting commercial fisheries landings only.

**Table 3.** Years when landings data provided by FGFRI were used as adjustments to the ICES landings statistics for some taxa included in our grouping of flatfishes and ‘others’.

Common name <sup>a</sup>	Scientific Name	Years
Ide	<i>Leuciscus idus</i>	1969-2007
Flounder	<i>Platichthys flesus</i>	1974-2007
Trout	Salmonidae	1974-2007
Eel	<i>Anguilla anguilla</i>	1976-2007
Roach	<i>Rutilus rutilus</i>	1979-2007
Freshwater species nei	-	1980-2007
Turbot	<i>Psetta maxima</i>	1996-2007
European plaice	<i>Pleuronectes platessa</i>	2006-2007
Whiting	<i>Merlangius merlangus</i>	2006-2007
Other (various)	-	1953-1979

<sup>a</sup>as defined by FGFRI

Adjustments were made for all taxa in years when FGFRI data indicated that catches were different than what was presented in the ICES landings statistics. However, careful attention was paid to not adjust landings for taxa that may have been included in another taxon or group. For example, a gap in cod data from 1959-1961 was not interpolated, as Finnish cod catches were so small during this period that they

**Table 4.** Anchor points (%) used for estimating unreported landings for cod, salmon and other taxa from 1950-2007 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	Western cod	Eastern cod	Salmon	Other taxa <sup>a</sup>
1950	5.0	5.0	5.0	5.0
1951-1979	-	-	-	-
1980	20.1	43.9	19.9	12.3
1981	-	-	6.4	-
1982	-	-	6.5	-
1983	-	-	7.1	-
1984	-	-	6.4	-
1985	-	-	5.8	-
1986	-	-	7.0	-
1987	-	-	6.5	-
1988	-	-	7.1	-
1989	-	-	7.1	-
1990	-	-	7.2	-
1991	-	-	5.8	-
1992	-	-	5.6	-
1993	40.2	87.7	5.9	24.6
1994	39.6	123.6	5.9	30.3
1995	-	29.7	6.2	-
1996	5.3	13.1	6.4	-
1997	-	-	6.5	-
1998	-	-	6.7	-
1999	-	-	6.6	-
2000	-	46.0	6.8	-
2001	-	47.5	6.6	-
2002	-	47.5	6.5	-
2003	-	59.8	6.7	-
2004	0.1	52.9	6.0	12.3
2005	0.0 <sup>b</sup>	46.4	6.2	11.2
2006	0.0 <sup>b, c</sup>	46.9	6.0	11.2 <sup>c</sup>
2007	0.0 <sup>b, c</sup>	43.2	6.5	11.2 <sup>c</sup>

<sup>a</sup> includes all taxa except cod and salmon. <sup>b</sup> less than 0.05. <sup>c</sup> rate from 2005 carried forward.

2008a) and salmon data (ICES, 2008b); and for all other taxa using our assumed default approach (Table 4; see 'Methods' in Zeller *et al.*, this volume). Other data sources also suggest that Finland has unreported landings. For example, when comparing import/export data and consumption patterns with landings, Ahvonen (1998) found that the unreported landings of salmon were approximately 16-33%. Ahvonen's method for estimating unreported catches was not used here, because unfortunately Finland's trade statistics for fisheries products have become much more aggregated since joining the EU in 1995. Unreported landings in the Baltic Sea have mainly focused on cod, and Finland has traditionally caught very little relative to the other Baltic countries. For this reason, the EU did not include Finland in its recent evaluation of the reliability of Baltic countries in reporting cod catches (Anon., 2007a).

### Discards

Discards were considered as four separate categories, each calculated as a rate by estimating discard tonnage as a proportion of reported landings from the respective sources. The four discard categories considered for Finland were: a) '*underwater discards*', which accounted for the mortality of fish lost from actively fishing gear prior to being brought on board; b) '*ghostfishing*' due to lost or abandoned fishing gear that continues to fish; c) '*boat-based discards*' usually resulting from fishers' catch retention behavior; and d) '*seal-damaged discards*' representing the fraction of catch discarded because of seal damage. To avoid the chance of double counting, seal discard data were used in place of boat-based discards when estimated seal-damaged discards were higher than boat-based discards. Rates for each

may have been included as part of the grouping 'others'. Trout were not adjusted either, as they were reported as a component of salmon catches from 1953-1973. Thus, our aim was to not risk double counting catches in order to remain conservative when making adjustments on a taxonomic basis.

### Unreported landings

Percentage rates for unreported landings were applied to the sum of ICES landings statistics plus adjustments to estimate total unreported landings for each respective taxon or group. Despite a dearth of information on Finnish unreported landings, it is likely that Finland did have some unreported landings between 1950 and 2007. For example, Finnish fishers are known to have been involved in large-scale operations to catch and sell unreported cod caught and sold in Sweden in the 1980s (P.-O. Larsson, pers. comm., Swedish Board of Fisheries). We estimated unreported landings from ICES stock assessment working group for cod (ICES, 2007;

**Table 5.** Anchor points (%) for estimating underwater discards for Finnish herring and sprat catches adjusted to reflect all landings based on Rahikainen *et al.* (2004)

Year	Underwater discard
1950-1979	2.50 <sup>a</sup>
1980	2.54
1981	2.06
1982	2.90
1983	3.86
1984	5.18
1985	5.59
1986	6.29
1987	5.36
1988	5.78
1989	6.70
1990	6.61
1991	7.23
1992	7.52
1993	7.21
1994	7.77
1995	8.12
1996	8.00
1997	8.30
1998	8.10
1999	8.50
2000	8.46
2001-2007	8.46 <sup>b</sup>

<sup>a</sup> 1980-1982 average carried back to 1950; <sup>b</sup>2000 rate carried forward unaltered to 2007.

category were applied to the estimated total landings of each respective taxon (i.e., ICES landings statistics + adjustments + unreported landings), giving an estimated total discard amount for each category. The sum of the discard amounts for each category gave us a total discards amount for Finland from 1950-2007.

*'Underwater discards'*: An underwater discard rate for herring of approximately 9% was estimated for catches from Finland's trawl fisheries in subdivision 32 from 1980-2000 based on Rahikainen *et al.* (2004). We applied this rate to all of herring landings by trawl for all years and subdivisions.

Data on the proportion of Finnish landings that were caught in trawl fisheries were only available from 1980-2000. The rate from 2000 was carried forward to 2007. To estimate the rate from 1950-1979, we used the average rate from 1980-1982. We used the same rates for sprat as both herring and sprat are pelagic species that are caught in a mixed fishery using similar gear-types. We adjusted the above rates to reflect landings by all gear-types (Table 5).

*'Ghostfishing'*: Ghostfishing is a worldwide problem that was highlighted in recent work by Macfadyen *et al.* (2009). Our estimate of Finland's ghostfishing discards was derived from a study by Tschernij and Larsson (2003), which estimated the amount of cod caught by lost gear in Sweden, and related these ghostfishing discards to commercial landings in Sweden. Estimates from this source were converted by Brown *et al.* (2005) into a range of ghostfishing rates. Here, we used the average of this range, which was estimated to be 1.65%. This rate was then applied to all taxa, except herring and sprat, for all years. Ghostfishing is mostly associated with lost gear that ends up on the bottom of the ocean so it is not a major concern for pelagic species such as herring and sprat.

*'Boat-based discards'*: Finland specific boat-based discard data were not available. Therefore, we relied on information from ICES stock assessment working group reports to estimate boat-based discards for salmon (ICES, 2008b) and cod (ICES, 2007; 2008a), and information from a Danish study (Anon., 2006) to derive estimates for the flatfishes and the group 'others' (see 'Methods' in Zeller *et al.*, this volume). For herring and sprat, we assumed a boat-based discard rate of 0% for herring and sprat during the entire study period, based on an ICES reports that indicates that boat-based discards for herring and sprat were almost non-existent (ICES, 2005a; 2007; 2008a).

*'Seal-damaged discards'*: Seal-damaged discards have been a political concern in the Baltic Sea since the 1980s when seal populations increased again from a previously depleted state (Österblom *et al.*, 2007). We assumed seal-damaged discards to be mostly a commercial fishing issue; therefore, we applied seal-discard rates to total landings data (ICES landings statistics + adjustments + unreported landings), but not to recreational catches. It is likely that a proportion of seal-damaged discards may have been included in accounts of boat-based discards for species targeted by seals. To avoid the possibility of double counting, seal-damaged discard rates replaced the boat-based discard rate in years when the seal-discard rate was higher.

Estimates of Finland's yearly seal-damaged discard tonnage were made available by FGfRI from 2000-2007 for herring, salmon, trout, whitefish, perch, pikeperch and vendace in ICES subdivisions 24-32. However, these estimates do not account for fish that are completely removed from fishing nets by seals prior to gear retrieval. A separate study investigating the removal of fish by seals from fixed gear in Sweden (Königson *et al.*, 2005; Anon., 2005) quantified this loss as 7.4 times the seal-damaged discards that were retained in the gear and brought to the surface. Thus, to account for total seal discards in coastal waters of Finland (Subdivisions 29-32) by fixed-gears, the reported discards provided by FGfRI were raised by a factor of 7.4. These discards were then transformed into a percentage of FGfRI reported commercial landings for the respective species or groups. We assumed a zero percent seal-damaged discarding rate for years prior to 1980, and interpolated rates linearly between 1980 and 2000 (Table 6). For herring, seal-damaged discard rates replaced boat-based discard rates from 1980-2007, as we assumed conservatively that boat-based discarding for these taxa was likely zero for the entire study period (see above).

**Table 6.** Anchor points (%) used for estimating for seal-damaged discard rates for herring based on sources (FGfRI, 2009; Königson, 2005). Boat-based discards were assumed to be zero from 1950-2007. Dashed line (-) indicates interpolated rates.

Year	Seal-damaged discard
1980	0.00
1981-1999	-
2000	0.09
2001	0.33
2002	0.10
2003	0.51
2004	0.06
2005	0.16
2006	0.25
2007	0.39

Seal-damaged discard rates for salmon, derived from FGFRI data, were compared to the boat-based salmon discard rates derived from ICES stock assessment working group data (see 'Methods' in Zeller *et al.*, this volume) for the period 1980-2007 (Table 7). To avoid potential double accounting due to damage caused by seals, only the higher discard rate between the two categories was used.

Species specific, seal-damaged discard rates for trout, whitefish, perch, pikeperch, and vendace were derived from FGFRI data and compared to the default boat-based discard rates for these species derived from a Danish study (Anon., 2006). The higher discard rate was chosen to avoid double accounting, in cases where seal-discards may have already been accounted for in the boat-based discards.

### Recreational catches

Estimates of Finland's recreational catches from the Baltic Sea were provided by our collaborators at FGFRI. FGFRI has undertaken studies to estimate recreational catches throughout most of the time period considered here (FGFRI, 2009). Recreational catches were estimated by FGFRI starting in 1953 and since 1986 these estimates have been done every other year with the exception of 1955-1958 and 1960-1961 when recreational catch surveys were not carried out. In years when recreational catch surveys were not done, FGFRI provided estimates of recreational catches for the non-surveyed years. For the period 1950-1952, we estimated annual recreational catches based on the average catch from 1953-1955 as reported by FGFRI.

Overall, our total reconstructed catch was the sum of ICES landings statistics, reported landings adjustments and estimates of unreported landings, discards and recreational catches. The estimated total reconstructed catch was then compared to the officially reported data, defined here as the ICES landings statistics.

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## RESULTS

ICES landing statistics for Finland totaled 4,468,766 t over the 1950-2007 time period (Figure 2). Landings according to ICES showed a steady increase over the study period from around 20,000 t in 1950 to approximately 100,000 t·year<sup>-1</sup> in the late 1970s. A significant decline in reported landings occurred in the early 1990s to roughly 75,000 t·year<sup>-1</sup>, followed by an increase from the mid-1990s to the early 2000s, with the highest reported landings of almost 130,000 t in 2007 (Figure 2).

### *Illegal, Unreported and Unregulated (IUU) catches*

Catches that were not presented in the ICES landings statistics were considered components of IUU. These included data source adjustments to ICES landings, unreported ('unallocated') landings, discards and recreational catches.

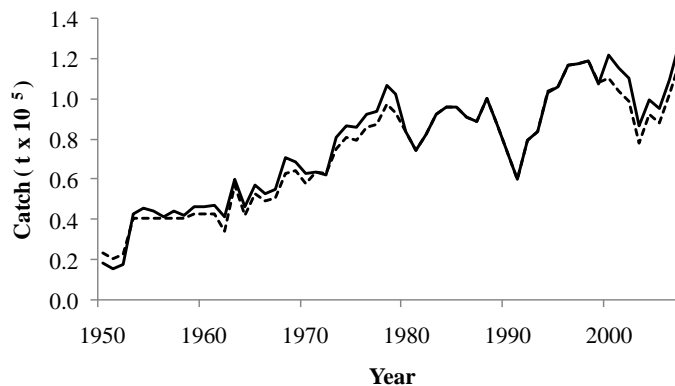
**Table 7.** Salmon discard rates (%) for boat-based discards derived from ICES stock assessment working group data (ICES, 2008b) and seal-damaged discards derived from FGFRI. Only the highest rate of the two discard categories was used. Values in *italics* indicate an interpolated rate.

Year	Discards		
	Boat-based	Seal-damaged	Rate used
1950-1980	14.44	0.00	14.44
1981	8.31	4.2	8.31
1982	8.29	8.46	8.46
1983	9.00	<i>12.68</i>	12.68
1984	8.14	<i>16.91</i>	16.91
1985	7.73	<i>21.14</i>	21.14
1986	8.77	<i>25.37</i>	25.37
1987	8.47	<i>29.59</i>	29.59
1988	8.61	<i>33.82</i>	33.82
1989	8.91	<i>38.05</i>	38.05
1990	10.17	<i>42.28</i>	42.28
1991	7.95	<i>46.50</i>	46.50
1992	7.83	<i>50.73</i>	50.73
1993	8.52	<i>54.96</i>	54.96
1994	7.80	<i>59.19</i>	59.19
1995	8.36	<i>63.42</i>	63.42
1996	8.99	<i>67.64</i>	67.64
1997	8.58	<i>71.87</i>	71.87
1998	8.58	<i>76.10</i>	76.10
1999	8.83	<i>80.33</i>	80.33
2000	5.76	84.55	84.55
2001	9.10	103.21	103.21
2002	9.61	95.66	95.66
2003	9.77	127.51	127.51
2004	9.10	94.37	94.37
2005	8.76	83.22	83.22
2006	10.02	95.97	95.97
2007	10.02	79.91	79.91



### Adjustments to ICES landings statistics

Negative adjustments of 180,437 t were made to the ICES landings statistics for Finland using national data sources. These adjustments were, in part, due to recreational catches being included in the ICES landings for some years over the period 1950-2007. Given that we accounted for recreational catches separately (see below), we excluded the recreational component from reported landings here, resulting in negative adjustments. Adjustments to landings were greatest in the late 1970s and throughout the 2000s (Table 8; Appendix Table A1). The most substantial adjustments to landings were for the group 'others'.



**Figure 2.** ICES landings statistics (solid line) and adjustments to ICES landings (dashed line) for Finland from 1950-2007

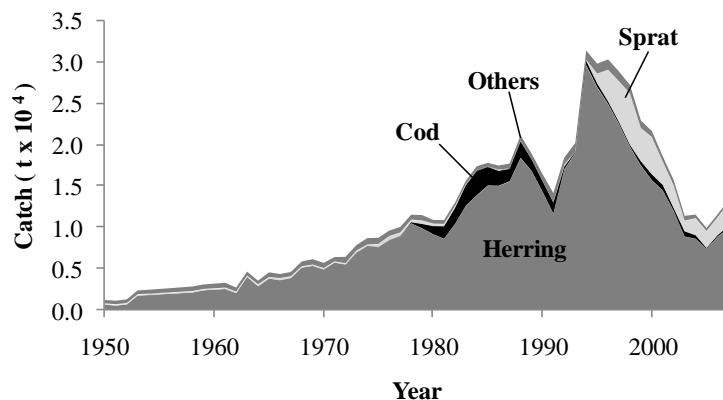
**Table 8.** Total adjustments (tonnes) to ICES landings statistics for Finland from 1950-2007.

Common name	1950-1959	1960-1969	1970-1979	1980-1989	1990-1999	2000-2007
Cod	216	-167	-3,390	-2	1	-38
Herring	-2,910	-10,246	-5,894	-1	-2	-5,532
Sprat	3,060	-107	-385	1	-2	-407
Flatfishes	0	0	-914	1	-6	-1,588
Salmon	127	-504	-473	3	1	-832
'Others'	-4,520	-35,333	-43,994	304	-157	-66,745

**Table 9.** Total estimated unreported landings (tonnes) of commercially targeted species in Finland from 1950-2007.

Common name	1950-1959	1960-1969	1970-1979	1980-1989	1990-1999	2000-2007
Cod	60	17	650	13,660	4,792	3,593
Herring	16,061	36,046	76,596	135,787	203,381	86,074
Sprat	1062	1,365	2,362	1,293	20,678	20,206
Flatfishes	0	0	49	92	199	72
Salmon	242	408	937	562	814	221
'Others'	4,777	5,354	6,683	4,917	10,452	4,053

be about 29,600 t·year<sup>-1</sup> in 1994. Estimated unreported landings of herring increased steadily from 675 t·year<sup>-1</sup> in 1950 to about 29,600 t·year<sup>-1</sup> in 1994 and then decreased to an average of approximately 8,700 t·year<sup>-1</sup> from 2003-2007. During the period 1950-2007, unreported landings of herring totaled over 550,000 t.



**Figure 3.** Finland's unreported landings by taxa for the period 1950-2007.

### Unreported landings

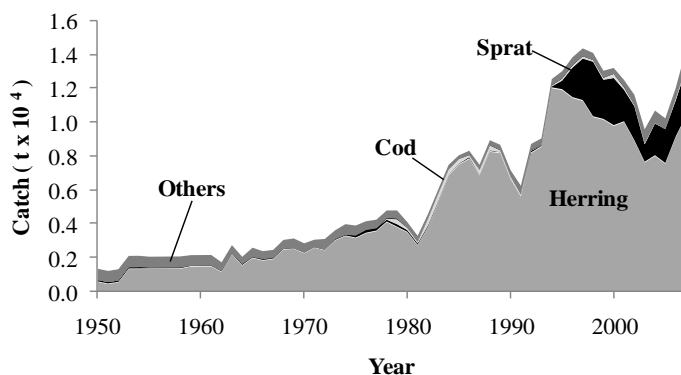
Estimated unreported landings for all taxa from 1950-2007 totaled approximately 663,500 t. Unreported landings increased steadily over the study period from about 1,000 t·year<sup>-1</sup> in 1950 to almost 21,000 t·year<sup>-1</sup> in 1988. After this, there was a slight decline before unreported landings increased again to a likely peak of over 31,000 t·year<sup>-1</sup> in 1994 (Figure 3; Appendix Table A1). Unreported landings declined steadily after that to about 13,000 t·year<sup>-1</sup> in 2007.

Herring represented the largest component of unreported landings, which were estimated to

be about 29,600 t·year<sup>-1</sup> in 1994. Estimated unreported landings of herring increased steadily from 675 t·year<sup>-1</sup> in 1950 to about 29,600 t·year<sup>-1</sup> in 1994 and then decreased to an average of approximately 8,700 t·year<sup>-1</sup> from 2003-2007. During the period 1950-2007, unreported landings of herring totaled over 550,000 t.

Unreported landings of cod were highest in 1984 adding approximately 3,000 t to the reported landings of 2,137 t for that year. Unreported landings of sprat were low from 1950-1994, averaging 146 t·year<sup>-1</sup>. After this period, a dramatic increase occurred during which unreported landings averaged approximately 3,100 t·year<sup>-1</sup> from 1995-2007 (Figure 3, Appendix Table A4). Unreported landings of salmon were relatively low over the entire study period, ranging from approximately 20 t·year<sup>-1</sup> to 150 t·year<sup>-1</sup> (Figure 3). Unreported landings of





**Figure 4.** Finland's discards by taxa for the period 1950-2007.

### Discards

Estimated total discards for all species from 1950-2007 were approximately 372,800 t (Figure 4). Discards increased steadily over the study period from about 1,400 t·year<sup>-1</sup> in 1950 to a peak of over 15,000 t·year<sup>-1</sup> in 1997. Discards were highest throughout the 1990s and into the 2000s. Herring accounted for the largest amount of discards and totaled approximately 291,000 t over the study period, with a peak in 1994 of over 12,000 t·year<sup>-1</sup> (Appendix Table A3). Over the study period, cod discards totaled 5,000 t. Salmon discards were substantial in comparison to reported salmon landings, adding nearly 16,000 t to the total reported ICES landings for salmon of 37,625 t from 1950-2007. Sprat discards were low throughout the first four decades of the study period, increasing dramatically in the mid-1990s and remaining substantial throughout the 2000s (Table 10). Flatfish discards were quite low, totaling around 1,300 t over the study period (Figure 4).

**Table 10.** Total estimated discards (tonnes) of commercially targeted species in Finland from 1950-2007.

Common name	1950-1959	1960-1969	1970-1979	1980-1989	1990-1999	2000-2007
Cod	90	13	445	2,414	789	850
Herring	11,267	18,810	31,922	61,142	96,551	71,694
Sprat	770	723	973	526	10,517	16,513
Flatfishes	0	0	237	318	492	258
Salmon	587	595	1,019	1,897	8,120	3,514
'Others'	6,569	5,402	5,362	2,747	4,165	5,158

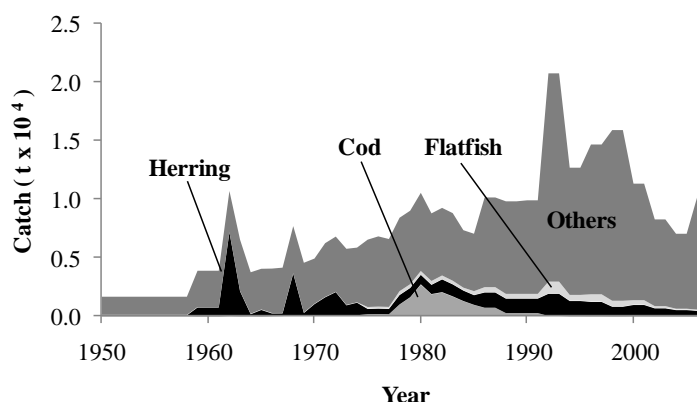
**Table 11.** Total recreational catches (t) for Finland, 1950-2007.

Common name	1950-1959	1960-1969	1970-1979	1980-1989	1990-1999	2000-2007
Cod	72	168	3,528	12,667	646	30
Herring	1,390	15,658	9,321	10,532	12,798	5,176
Sprat	132	390	475	433	30	340
Flatfishes	-	-	1,001	3,338	5,922	1,366
Salmon	141	513	629	1,293	1,736	644
'Others'	17,015	37,053	52,704	64,920	128,01	66,786

### Recreational catch

Total catches for Finland's recreational fisheries in the Baltic Sea from 1950-2007 were reported as 456,679 t (Figure 5). Note that Finland reports recreational catches nationally and that the national data set provided by FGRI had separate accounting for commercial landings and for recreational catches.

Recreational catches increased steadily from around 1,600 t·year<sup>-1</sup> in 1950 to between 10,000 t·year<sup>-1</sup> and 20,000 t·year<sup>-1</sup> in the 1990s (Figure 5, Appendix Table A1). The majority of recreational catches were of 'other species', which represented 80% of the total recreational



**Figure 5.** Finland's recreational catches by taxa from 1950-2007.

flatfishes were minimal totaling about 400 t over the time period 1974-2007. The group of flatfishes, which included European flounder, European plaice and turbot, represented a very small proportion of estimated unreported landings due in part to our assumption that from 1950-1973 landings of flatfishes were reported as one of the 'miscellaneous' categories included within the group 'others'. From 1950-2007, unreported landings of 'others' totaled approximately 36,000 t (Appendix Table A7).

catch for Finland from 1950-2007. Herring represented 12%, cod 4%, salmon 1%, and sprat contributed less than 0.4% of total recreational catches over the entire study period (Figure 5). Recreational catches of 'others' totaled over 366,000 t from 1950-2007 and were most substantial during the 1990s (Table 11).

### Total reconstructed catches

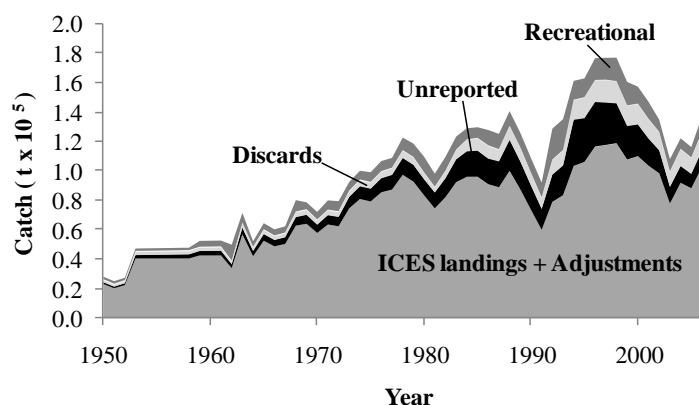
The total catch for Finland as reconstructed here combined reported ICES landings statistics, adjustments, unreported landings, discards and recreational catches, (Table 12, Figure 6). The total reconstructed catch was estimated to be 5,781,000 t for the period 1950-2007 (Appendix Table A1). This compares to the 4,468,766 t that was reported in the ICES landings statistics for the same period (Figure 7).

This discrepancy of over 29% between officially reported landings and estimated total catches was due to significant quantities of unreported landings and discards (since recreational catches were included, at least partially, in the data reported by ICES on behalf of Finland).

Unreported landings and discard estimates added over 1 million t to the reported landings (Figure 7). The majority of unreported landings and discards were attributed to fisheries involving herring. Recreational fisheries, dominated by the group 'others', accounted for approximately 500,000 t from 1950-2007. The cod fishery in Finland was modest compared to those in other Baltic countries; however, unreported landings, discards and recreational catches of cod together totaled approximately 45,000 t between 1950 and 2007, an increase of 67% to data reported in the ICES landings statistics (Figure 7). Overall, unreported landings, discards and recreational catches represented 12%, 6% and 8% of the total reconstructed catch for Finland, respectively (Figure 6).

### DISCUSSION

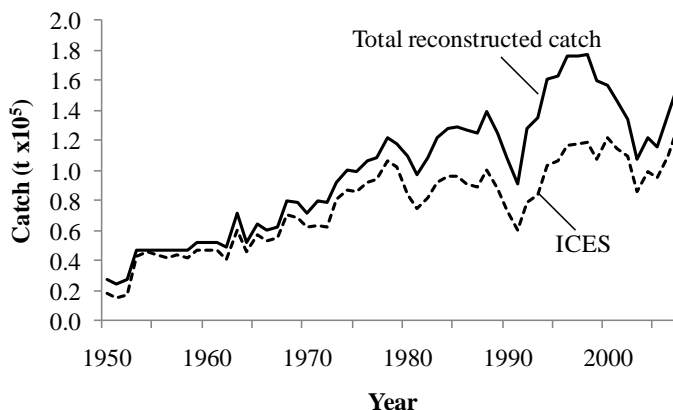
Our reconstruction of Finland's total catch, including reported landings from ICES landings statistics (ICES, 2009), adjustments to landings, unreported landings, discards, and recreational catches, totaled approximately 5.8 million tonnes for the period 1950 to 2007. Finland's annual landings data as reported by ICES total approximately 4.5 million tonnes for the same period (1950-2007). The difference of approximately 1.3 million tonnes (29%) between ICES data and our total catch reconstruction suggests the magnitude of IUU catches in



**Figure 6.** Finland's total reconstructed catch by component from 1950-2007.

**Table 12.** Total reconstructed catches (tonnes) of commercially targeted species in Finland from 1950-2007.

Common name	1950-1959	1960-1969	1970-1979	1980-1989	1990-1999	2000-2007
Cod	924	290	6,839	61,978	19,866	12,916
Herring	284,129	487,684	810,368	1,020,216	1,123,617	769,876
Sprat	19,450	18,528	24,887	11,028	117,288	180,182
Flatfishes	0	0	1,714	4,298	7,409	2,154
Salmon	4,374	4,806	7,984	11,107	23,735	7,812
'Others'	106,839	110,913	126,018	102,481	184,960	104,331



**Figure 7.** Total reconstructed catch and ICES landings statistics for Finland from 1950-2007.

Finland between 1950 and 2007. The discrepancy between these datasets (estimating landings versus estimating catches) displays the significant mortality rates and impacts on the Baltic ecosystem that are not accounted for. This discrepancy can mislead the public and complicates the decision making process for policy makers who are forced to rely on incomplete or underestimated catch records when setting TACs or deciding upon other management strategies (closures, gear restrictions, etc.).

Our estimates of IUU catches were based on conservative methods and our catch reconstruction is thought to underestimate the total catch between 1950 and 2007. However, it undoubtedly provides a more accurate baseline than current statistics available from ICES which assume zero IUU catches. Even though our catch reconstruction presents a 29% increase in catches between 1950 and 2007 (as compared to ICES landings statistics), Finland's total estimate of IUU was one of the lowest of all Baltic countries. This is due in part because of Finland's exemplary efforts at accounting for the recreational fishing sector since 1953. Landings reported to ICES since this time have included recreational catches, meaning the majority of IUU catches unaccounted for in Finland were comprised of unreported landings and discards. The Finnish Game and Fisheries Research Institute (FGFRI) provided us with all commercial and recreational landings data from 1953 to present. FGFRI data were more comprehensive than data presented by ICES on behalf of Finland. Adjustments were made to ICES data with a national dataset that displayed a greater degree of transparency and accountability in Finnish fisheries management compared to other Baltic countries.

Our catch reconstruction showed herring to be the species most affected by IUU fishing in Finland since 1950. This is due in part to the fact that herring is the most important species fished in Finland by volume. Unreported landings of herring were estimated to be about 560,000 tonnes, and discards of herring were estimated to total approximately 300,000 tonnes between 1950 and 2007. Unreported landings of cod in Finland were only 4% of the amount of unreported landings of herring when summed over the period of study (1950-2007). The Finnish Ministry of Agriculture and Forestry reports that the majority of cod fishing occurs outside of the Finnish EEZ and that in 2005, most cod landings were made in Swedish and Danish ports, with zero cod landings in Finnish ports (Anon., 2007b). Finland's unreported landings of cod still represented about 37% of cod landings reported to ICES between 1950 and 2007 (i.e., catch volumes of cod are low, but the rate of underreporting is relatively high).

As a Member of the EU, Finland is required to enforce the regulations of the Common Fisheries Policy (CFP), and to report details on serious infringements to the European Commission (EC; the legislative arm of the EU). These rules were formed in an effort to encourage transparency and consistency between Member States with regards to CFP enforcement. In 2003, 18 serious infringements were reported by Finland (50% of the total number of infringements in Finland) and the average fine was a low €282. This is compared to already low Baltic-wide average fine of €464. However, little direct comparison can be made between these figures, since there are no standards for evaluating fishers' behaviors among EU members. When a Member state is believed to be in noncompliance with Community laws, the Commission can issue a request for a written description of the country's observations relating to the subject of investigation. If the opinion of the Community remains unchanged after receiving this written report, court proceedings can be initiated. In 2004, two procedures were initiated against Finland for exceeding catch quotas, and one procedure was initiated for failing to provide catch or fishing effort data to the EC (Anon., 2007b).

Little information regarding discards in Finland was available from national or ICES datasets. However, estimates of discards caused by seal-induced damages were available from the FGFRI. These records were augmented using a Swedish study to include the mortalities of fish removed completely from nets by seals. The most significantly affected species by seal-induced damages was salmon, as approximately 26% of the total reconstructed salmon catch was discarded (this proportion includes boat-based, ghostfishing and seal-induced discards). Some progress has been made in modified gear designs and the choice of netting material used to build trap-nets to protect fish from seal damage. Three out of five modified gear models examined by Siira, (2007) were considered to be successful. The pontoon trap was noted as the most successful of those tested, where seal-induced damages were practically non-existent (Hemmingsson *et al.*, 2008). Protection from seal damage is necessary, as coastal salmon fishers in the Gulf of Bothnia have been severely challenged by related socio-economic factors in recent decades. Salmon populations were considered to have recovered in the early 1990s after reductions were made in the Baltic TAC for the species, and strict seasonal closures were enforced. However, drastic increases in recreational fishing of salmon since this time, in addition to vast increases in grey seal populations have left commercial salmon fishers with inadequate stock sizes to maintain their livelihoods. Less vulnerable trapping methods will

lessen the pressures induced by fisheries on salmon stocks, as well as allow more accurate accounting of salmon catches, as estimates of salmon taken by seals from set trap-nets would be unnecessary.

Discards of herring were the most substantial by volume. The total discards of herring accounted for almost 80% of the discards of all taxa between 1950 and 2007. Though discards of herring were substantial by volume, they accounted for only 8% of the total reported landings of herring by ICES, and 6.5% of the overall reconstructed catch of herring between 1950 and 2007. This emphasizes how little economic incentive there is to high-grade fish destined for industrial purposes. The second most affected species by discards was sprat, which is due to it being caught as bycatch in the pelagic herring fishery. Discards of flatfishes were the least severe (by volume) out of all Finnish fisheries, but represented about 25% of the total landings of flatfishes reported to ICES and the responsible fishing behaviors may be of significant concern. Flatfishes also represented a fairly large portion of the recreational catches, with over 11,000 tonnes reported over the period of study.

Recently, ICES reported some improvement of the eastern Baltic cod stock and recommended an increase of the TAC by 15%. This is the maximum amount allowed under the EU's management plan for Baltic cod fishing (Veem, 2009). The observed improvement in stock size, however, has not elevated cod abundance beyond what are considered historically low levels, which are still far from what would be considered sustainable in the long-term. Historically, ICES' scientifically-recommended TAC levels for the management of cod stocks have been increased due to so-called socio-economic factors within the fishing industry. It has been commonplace for ICES TAC recommendations to be increased by a factor of 3 during negotiations with the European Council of Ministers (WWF, 2006) and Russia.

Our methods used all the information available to combine reported landings with estimates of IUU catches. Apart from the adjustments to commercial landings and recreational catches that were obtained from the dataset provided by the FGFRI, the majority of our estimates were derived from Baltic-wide data presented in ICES stock assessment working group reports. The number of countries whose discards or unreported ('unallocated') landings are included in these Baltic-wide estimates is unknown due to publicly non-transparent confidentiality agreements. Thus, in some sense, under current regulations, countries are able to remain anonymous and relatively unaccountable for IUU fishing. Though some of these data are available to the stock assessment community within ICES, the 'true' level of catches lacks transparency to the public who are the ultimate beneficiaries and owners of a common resource.

Increased transparency with regard to all fisheries catches is necessary in order for all stakeholders to be informed and to become involved in the future well-being of the Baltic Sea ecosystem. In addition to increased accountability and transparency of IUU catches of target species, regulations should require accountability for all species caught by fishing gear whether or not they are economically valuable, or whether they are discarded or brought to port. When all catches resulting from fishing gear are accounted for, management can begin to evolve towards an ecosystem-based management system that considers the whole ecosystem rather than focusing on single species in isolation from their environment. Records of these catches will facilitate the modeling of Baltic Sea ecosystems and key ecosystem processes governing some of the observed issues. Such baseline data would also provide the tools required to generate scenarios illustrating various management protocols and allow decision-makers and the public to make decisions based upon various biological, social and economic factors that incorporate both short- and long-term goals. An ecosystem-based management system will also require the cooperation of all Baltic countries to contribute such data, so the ecosystem can be considered in its entirety.

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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 Finland (t).

Year	ICES landing statistics	Adjustments	Un-reported	Dis-cards	Re-creational	Total
1950	18,838	4,756	1,180	1,394	1,643	27,811
1951	15,725	5,037	1,090	1,268	1,643	24,763
1952	17,705	5,178	1,258	1,368	1,643	27,152
1953	42,669	-1,780	2,346	2,155	1,643	47,033
1954	45,800	-4,911	2,447	2,160	1,643	47,139
1955	44,100	-3,211	2,547	2,166	1,643	47,245
1956	41,500	-611	2,648	2,171	1,643	47,351
1957	44,100	-3,211	2,748	2,176	1,643	47,456
1958	42,200	-1,311	2,849	2,181	1,643	47,562
1959	46,871	-3,963	3,089	2,245	3,963	52,204
1960	46,700	-3,792	3,193	2,250	3,964	52,315
1961	46,900	-3,992	3,298	2,255	3,965	52,426
1962	41,361	-7,019	2,728	1,830	10,711	49,611
1963	60,349	-3,198	4,671	2,846	6,576	71,244
1964	46,230	-3,819	3,577	2,174	3,791	51,953
1965	56,958	-4,092	4,581	2,693	4,093	64,233
1966	52,909	-3,831	4,371	2,479	4,106	60,034
1967	54,834	-4,160	4,641	2,581	4,161	62,057
1968	70,820	-7,765	5,927	3,173	7,764	79,919
1969	69,002	-4,689	6,202	3,262	4,651	78,429
1970	62,814	-4,704	5,745	2,958	5,100	71,913
1971	63,798	13	6,464	3,187	6,298	79,761
1972	62,615	0	6,500	3,239	6,879	79,233
1973	80,638	-5,842	7,950	3,769	5,842	92,356
1974	86,928	-5,900	8,824	4,161	5,900	99,913
1975	85,626	-6,250	8,846	4,069	6,591	98,882
1976	92,166	-6,591	9,736	4,324	6,875	106,510
1977	94,057	-6,646	10,165	4,418	6,646	108,640
1978	106,655	-9,271	11,597	4,921	8,462	122,364
1979	102,671	-9,859	11,449	4,912	9,065	118,238
1980	83,558	-1	10,739	4,241	10,601	109,137
1981	74,663	42	10,493	3,395	8,866	97,459
1982	82,229	37	12,465	4,637	9,348	108,715
1983	92,337	37	15,001	6,124	8,879	122,377
1984	96,031	43	16,630	7,684	7,497	127,885
1985	96,074	31	17,237	8,263	7,194	128,800
1986	91,016	21	17,049	8,593	10,393	127,072
1987	88,914	55	17,374	7,775	10,393	124,511
1988	100,002	38	20,644	9,197	9,916	139,797
1989	87,619	2	18,679	9,137	9,916	125,353
1990	73,716	12	16,275	8,178	10,003	108,184
1991	60,249	-15	13,907	7,268	10,003	91,412
1992	79,143	-31	18,511	9,802	20,991	128,416
1993	83,570	37	20,308	10,066	20,991	134,971
1994	103,420	0	31,479	13,269	12,784	160,952
1995	106,093	-35	29,996	13,862	12,784	162,701
1996	116,597	-32	30,420	14,599	14,843	176,428
1997	117,619	-25	29,004	15,229	14,843	176,671
1998	118,829	-55	27,367	14,740	15,951	176,831
1999	107,711	-23	23,049	13,622	15,951	160,309
2000	121,643	-11,621	21,773	13,797	11,542	157,134
2001	115,268	-11,746	18,681	13,038	11,542	146,784
2002	110,030	-11,628	15,791	12,128	8,273	134,595
2003	86,314	-8,326	11,463	10,105	8,273	107,828
2004	99,163	-7,169	11,597	11,257	7,111	121,959
2005	95,476	-7,180	9,964	10,692	7,111	116,062
2006	109,780	-7,162	11,602	12,377	10,245	136,842
2007	128,164	-10,311	13,360	14,611	10,245	156,068



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

Year	ICES landing statistics	Adjust- ments	Un- reported	Dis- cards	Re- creational	Total
1950	0	78	4	10	8	100
1951	0	78	5	10	8	100
1952	0	78	5	10	8	101
1953	86	-8	6	10	8	102
1954	100	-22	7	10	8	103
1955	100	-22	7	10	8	103
1956	100	-22	8	10	8	104
1957		78	9	10	8	105
1958	100	-22	9	10	8	106
1959	0	0	0	0	0	0
1960	0	0	0	0	0	0
1961	0	0	0	0	0	0
1962	27	-13	2	2	14	32
1963	12	-5	1	1	5	14
1964	16	-9	1	1	9	18
1965	23	-3	4	3	3	29
1966	26	-12	3	2	12	30
1967	27	-21	1	1	21	29
1968	70	-54	3	2	54	75
1969	58	-50	2	1	50	61
1970	70	-50	4	2	50	77
1971	3	0	1	0	50	54
1972	8	0	2	1	68	79
1973	95	-77	5	2	77	102
1974	160	-90	18	11	90	189
1975	298	-170	34	20	182	364
1976	278	-182	27	5	190	317
1977	310	-183	36	5	183	351
1978	1,446	-1,013	127	96	1,013	1,669
1979	2,938	-1,625	397	302	1,625	3,637
1980	2,317	-1	720	160	2,724	5,921
1981	3,249	0	1,088	142	1,892	6,371
1982	3,904	0	1,400	398	2,054	7,756
1983	4,677	0	1,789	410	1,699	8,575
1984	5,257	0	2,137	296	1,302	8,992
1985	3,793	0	1,632	258	980	6,663
1986	2,917	0	1,325	122	732	5,097
1987	2,309	-1	1,104	256	732	4,399
1988	2,903	0	1,457	269	276	4,905
1989	1,913	1	1,007	104	276	3,300
1990	1,667	1	917	121	276	2,983
1991	1,662	1	954	102	276	2,995
1992	460	2	276	38	27	803
1993	203	0	126	17	27	373
1994	521	-1	533	39	10	1,102
1995	1,851	1	540	97	10	2,499
1996	3,133	0	320	106	7	3,565
1997	1,537	-1	294	102	7	1,939
1998	1,034	0	288	69	3	1,393
1999	1,571	-2	543	99	3	2,214
2000	1,825	-7	762	227	7	2,813
2001	1,725	-8	729	133	7	2,586
2002	1,052	-7	376	75	5	1,500
2003	1,168	-6	678	90	5	1,937
2004	889	-3	454	48	3	1,391
2005	287	-3	130	20	3	436
2006	673	-3	201	118	0	989
2007	853	0	273	140	0	1,265

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

Year	ICES landing statistics	Adjust- ments	Un- reported	Dis- cards	Re- creational	Total
1950	13,454	0	673	586	72	14,785
1951	10,669	0	559	466	72	11,766
1952	12,759	0	700	559	72	14,089
1953	31,000	-187	1,765	1,352	72	34,002
1954	32,600	-1,787	1,840	1,355	72	34,080
1955	31,700	-887	1,915	1,358	72	34,158
1956	30,000	813	1,989	1,361	72	34,236
1957	31,300	-487	2,064	1,365	72	34,314
1958	29,900	913	2,139	1,368	72	34,391
1959	34,939	-1,288	2,418	1,497	742	38,308
1960	34,400	-749	2,499	1,500	743	38,394
1961	34,400	-749	2,581	1,504	744	38,480
1962	31,140	-4,866	2,079	1,177	7,122	36,652
1963	48,632	942	4,043	2,225	2,112	57,954
1964	34,904	-225	2,912	1,560	162	39,313
1965	44,916	-532	3,835	2,001	532	50,752
1966	41,141	-96	3,646	1,855	224	46,770
1967	42,931	-221	3,898	1,934	220	48,762
1968	58,700	-3,527	5,169	2,504	3,575	66,421
1969	56,252	-223	5,385	2,549	224	64,187
1970	51,205	-984	4,949	2,290	979	58,438
1971	57,188	0	5,774	2,613	1,557	67,132
1972	53,758	0	5,558	2,462	1,980	63,758
1973	67,071	-850	7,007	3,039	850	77,117
1974	73,066	-1,060	7,794	3,312	1,060	84,172
1975	69,581	-560	7,639	3,182	436	80,277
1976	75,581	-436	8,499	3,472	455	87,570
1977	78,051	-440	8,966	3,593	440	90,610
1978	89,792	-788	10,498	4,130	788	104,420
1979	83,130	-776	9,913	3,829	776	96,873
1980	74,852	0	9,192	3,521	795	88,361
1981	65,389	0	8,648	2,752	775	77,564
1982	73,501	0	10,415	3,824	1,076	88,816
1983	83,679	0	12,647	5,319	1,009	102,654
1984	86,545	0	13,898	6,880	877	108,200
1985	88,702	0	15,082	7,536	810	112,130
1986	83,800	0	15,041	7,878	1,285	108,003
1987	82,522	-1	15,591	6,908	1,285	106,304
1988	92,824	0	18,414	8,302	1,220	120,760
1989	81,122	0	16,859	8,223	1,220	107,424
1990	66,078	0	14,357	6,681	1,220	88,335
1991	51,546	0	11,686	5,648	1,220	70,100
1992	72,171	-1	17,044	8,226	1,880	99,320
1993	77,353	0	18,998	8,595	1,880	106,826
1994	97,674	-1	29,617	12,071	1,285	140,646
1995	94,613	-1	26,980	11,962	1,285	134,839
1996	93,337	1	24,931	11,492	1,210	130,971
1997	90,334	0	22,498	11,316	1,210	125,358
1998	85,545	0	19,760	10,356	804	116,465
1999	82,237	0	17,511	10,204	804	110,756
2000	81,648	-951	15,726	9,835	951	107,209
2001	82,867	-951	14,484	10,062	951	107,413
2002	76,530	-950	11,999	8,945	663	97,187
2003	64,021	-663	8,915	7,672	663	80,607
2004	71,073	-521	8,653	8,054	520	87,779
2005	66,978	-521	7,442	7,593	520	82,012
2006	79,955	-522	8,895	9,149	454	97,932
2007	89,392	-453	9,960	10,384	454	109,737

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

Year	ICES landing statistics	Adjustments	Un-reported	Dis-cards	Re-creational	Total
1950	552	1,227	89	78	5	1,950
1951	693	1,086	93	78	5	1,955
1952	522	1,257	98	78	5	1,959
1953	1,797	-18	102	78	5	1,964
1954	1,900	-121	106	78	5	1,968
1955	1,700	79	111	78	5	1,973
1956	1,600	179	115	79	5	1,977
1957	1,800	-21	119	79	5	1,982
1958	2,300	-521	123	79	5	1,986
1959	1,562	-87	106	66	87	1,734
1960	1,500	-25	110	66	87	1,737
1961	1,600	-125	113	66	87	1,741
1962	1,557	5	124	70	19	1,775
1963	1,399	-23	112	62	21	1,571
1964	2,111	12	178	96	17	2,414
1965	1,637	-40	138	72	40	1,847
1966	2,048	189	199	101	20	2,557
1967	1,896	-11	172	85	11	2,153
1968	1,291	-42	117	57	42	1,465
1969	1,118	-47	103	49	46	1,269
1970	1,265	-90	116	54	90	1,434
1971	994	0	100	45	24	1,164
1972	972	0	100	45	35	1,152
1973	1,854	-38	192	83	38	2,130
1974	1,035	-40	108	46	40	1,188
1975	2,854	-20	314	131	49	3,327
1976	3,778	-49	422	172	51	4,374
1977	3,213	-49	366	146	49	3,725
1978	2,373	-50	274	108	50	2,755
1979	3,125	-49	370	143	49	3,638
1980	2,137	0	262	101	53	2,554
1981	1,895	0	251	80	57	2,282
1982	1,468	0	208	76	70	1,822
1983	828	0	125	53	47	1,053
1984	374	0	60	30	47	511
1985	364	0	62	31	47	504
1986	705	0	126	66	56	953
1987	287	0	54	24	56	421
1988	495	0	98	44	0	638
1989	222	0	46	22	0	291
1990	162	0	35	16	0	214
1991	99	0	22	11	0	132
1992	893	-1	211	101	0	1,204
1993	206	-1	50	23	0	278
1994	497	-1	151	61	0	708
1995	4,103	1	1,170	515	0	5,790
1996	14,351	0	3,833	1,754	0	19,939
1997	19,852	-1	4,944	2,468	0	27,263
1998	27,014	0	6,240	3,244	15	36,513
1999	18,886	0	4,021	2,324	15	25,246
2000	23,242	-108	4,508	2,795	108	30,545
2001	15,849	-107	2,783	1,873	108	20,506
2002	17,354	-109	2,738	2,020	12	22,015
2003	8,961	-12	1,259	1,032	12	11,253
2004	16,584	-8	2,033	1,881	6	20,497
2005	17,894	-11	2,003	2,010	6	21,902
2006	19,020	-7	2,129	2,137	44	23,324
2007	24,626	-45	2,753	2,763	44	30,142

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

Year	ICES landing statistics	Adjust- ments	Un- reported	Dis- cards	Re- creational	Total
1950	399	0	20	67	12	498
1951	352	0	19	60	12	443
1952	383	0	23	65	12	483
1953	350	-15	22	57	12	426
1954	300	35	23	58	12	428
1955	300	35	25	58	12	430
1956	300	35	27	58	12	432
1957	300	35	28	58	12	434
1958	300	35	30	59	12	436
1959	293	-33	25	46	33	363
1960	300	-40	26	46	33	365
1961	300	-40	27	46	33	366
1962	265	41	34	55	36	430
1963	368	-60	35	55	61	460
1964	465	-58	49	73	61	590
1965	339	-40	37	54	41	431
1966	324	-70	33	46	57	390
1967	425	-42	52	70	43	547
1968	513	-115	56	73	67	594
1969	495	-80	60	76	81	632
1970	450	-124	49	60	124	559
1971	401	0	62	74	77	614
1972	456	0	73	85	83	697
1973	640	-87	91	104	87	835
1974	747	-40	120	133	40	1,000
1975	703	-50	114	123	44	934
1976	686	-44	115	122	46	925
1977	699	-44	121	125	44	945
1978	532	-41	93	94	41	719
1979	558	-43	100	99	43	757
1980	550	-2	109	106	51	814
1981	658	0	42	70	66	836
1982	505	-3	32	54	66	654
1983	544	0	39	84	66	732
1984	946	0	61	187	143	1,337
1985	815	0	47	197	143	1,202
1986	843	-1	59	243	234	1,378
1987	817	9	53	275	234	1,388
1988	653	0	46	248	145	1,093
1989	1,021	0	73	434	145	1,673
1990	2,058	0	148	969	145	3,320
1991	1,935	0	112	986	145	3,178
1992	1,886	-2	105	1,042	288	3,319
1993	1,619	2	96	972	288	2,978
1994	1,049	0	62	676	139	1,926
1995	1,160	0	71	801	139	2,172
1996	975	0	62	719	217	1,973
1997	1,051	0	68	823	217	2,159
1998	720	0	49	597	79	1,445
1999	612	0	40	535	79	1,266
2000	744	-153	40	544	152	1,327
2001	596	-152	29	496	152	1,122
2002	594	-153	29	457	33	960
2003	377	-34	23	473	33	872
2004	607	-102	30	514	103	1,153
2005	562	-101	29	416	103	1,008
2006	413	-104	19	320	34	682
2007	372	-33	22	294	34	689

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

Year	ICES landing statistics	Adjust- ments	Un- reported	Dis- cards	Re- creational	Total
1950	0	0	0	0	0	0
1951	0	0	0	0	0	0
1952	0	0	0	0	0	0
1953	0	0	0	0	0	0
1954	0	0	0	0	0	0
1955	0	0	0	0	0	0
1956	0	0	0	0	0	0
1957	0	0	0	0	0	0
1958	0	0	0	0	0	0
1959	0	0	0	0	0	0
1960	0	0	0	0	0	0
1961	0	0	0	0	0	0
1962	0	0	0	0	0	0
1963	0	0	0	0	0	0
1964	0	0	0	0	0	0
1965	0	0	0	0	0	0
1966	0	0	0	0	0	0
1967	0	0	0	0	0	0
1968	0	0	0	0	0	0
1969	0	0	0	0	0	0
1970	0	0	0	0	0	0
1971	0	0	0	0	0	0
1972	0	0	0	0	0	0
1973	0	0	0	0	0	0
1974	55	0	6	30	0	91
1975	100	-50	6	28	131	214
1976	194	-131	7	35	137	242
1977	203	-132	8	39	132	251
1978	390	-303	10	48	303	449
1979	399	-298	12	56	298	467
1980	52	0	6	29	304	392
1981	78	0	10	44	304	437
1982	50	0	7	28	310	396
1983	39	0	6	22	286	353
1984	43	0	7	25	224	299
1985	37	0	6	22	310	375
1986	52	0	9	31	426	518
1987	58	0	11	34	426	529
1988	70	0	14	41	374	499
1989	70	0	15	42	374	501
1990	59	-1	13	35	374	481
1991	76	-1	17	46	374	512
1992	65	0	15	40	1,009	1,128
1993	85	-1	21	52	1,009	1,166
1994	79	-1	24	51	486	638
1995	89	0	25	57	486	657
1996	99	0	26	62	617	804
1997	85	1	21	53	617	777
1998	82	-3	18	48	475	621
1999	83	0	18	49	475	624
2000	454	-373	16	47	374	518
2001	504	-373	23	76	374	603
2002	452	-375	12	44	155	289
2003	200	-157	6	24	155	227
2004	121	-84	5	20	79	141
2005	106	-79	3	15	79	124
2006	103	-72	3	16	75	125
2007	107	-74	4	16	75	128

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

Year	ICES landing statistics	Adjust- ments	Un- reported	Dis- cards	Re- creational	Total
1950	4,433	3,451	394	653	1,546	10,477
1951	4,011	3,873	413	655	1,546	10,498
1952	4,041	3,843	432	656	1,546	10,519
1953	9,436	-1,552	452	658	1,546	10,539
1954	10,900	-3,016	471	659	1,546	10,560
1955	10,300	-2,416	490	661	1,546	10,581
1956	9,500	-1,616	509	662	1,546	10,601
1957	10,700	-2,816	528	664	1,546	10,622
1958	9,600	-1,716	547	665	1,546	10,643
1959	10,077	-2,555	540	636	3,101	11,800
1960	10,500	-2,978	559	638	3,101	11,819
1961	10,600	-3,078	577	639	3,101	11,839
1962	8,372	-2,186	489	527	3,520	10,722
1963	9,938	-4,052	480	502	4,377	11,245
1964	8,734	-3,539	436	444	3,542	9,618
1965	10,043	-3,477	567	563	3,477	11,173
1966	9,370	-3,842	491	475	3,793	10,287
1967	9,555	-3,865	519	490	3,866	10,565
1968	10,246	-4,027	583	537	4,026	11,364
1969	11,079	-4,289	653	587	4,250	12,280
1970	9,824	-3,456	627	552	3,857	11,404
1971	5,212	13	528	454	4,590	10,796
1972	7,421	0	767	646	4,713	13,547
1973	10,978	-4,790	655	540	4,790	12,173
1974	11,865	-4,670	779	629	4,670	13,273
1975	12,090	-5,400	740	586	5,749	13,766
1976	11,649	-5,749	667	518	5,996	13,081
1977	11,581	-5,798	668	509	5,798	12,758
1978	12,122	-7,076	595	445	6,267	12,353
1979	12,521	-7,068	656	482	6,274	12,865
1980	3,650	1	448	323	6,674	11,097
1981	3,394	42	454	307	5,772	9,969
1982	2,801	41	403	256	5,772	9,272
1983	2,570	37	394	237	5,772	9,010
1984	2,866	42	467	266	4,904	8,546
1985	2,363	31	407	221	4,904	7,925
1986	2,699	22	488	253	7,660	11,123
1987	2,921	49	561	279	7,660	11,470
1988	3,058	38	614	293	7,901	11,904
1989	3,271	1	680	312	7,901	12,165
1990	3,691	12	805	356	7,988	12,851
1991	4,931	-15	1,114	476	7,988	14,494
1992	3,669	-29	860	355	17,787	22,641
1993	4,103	36	1,017	407	17,787	23,349
1994	3,600	4	1,093	371	10,864	15,931
1995	4,277	-36	1,209	430	10,864	16,744
1996	4,702	-32	1,247	467	12,792	19,176
1997	4,760	-23	1,180	467	12,792	19,175
1998	4,434	-52	1,012	426	14,575	20,394
1999	4,322	-21	916	412	14,575	20,203
2000	13,731	-10,028	722	349	9,950	14,723
2001	13,728	-10,154	632	398	9,950	14,554
2002	14,048	-10,033	637	588	7,405	12,645
2003	11,586	-7,454	581	815	7,405	12,933
2004	9,889	-6,451	422	739	6,400	10,998
2005	9,649	-6,465	357	639	6,400	10,580
2006	9,616	-6,454	354	637	9,638	13,792
2007	12,814	-9,706	348	1,012	9,638	14,106

