Stock Annex: Greater silver smelt (*Argentina silus*) in Subareas 1, 2, and 4, and in Division 3.a (Northeast Arctic, North Sea, Skagerrak and Kattegat)

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	Greater silver smelt
Working Group:	Working Group on Biology and Assessment of Deep-sea Fisheries Resources (WGDEEP)
Created:	
Authors:	
Last updated:	May 2019
Last updated by:	WGDEEP

A. General

A.1 Stock definition

Gr. silver smelt (*Argentina silus*) in Subareas 1, 2, 4 and Division 3.a is from 2015 onwards treated as one management unit/stock.

The current perception is based on the historical and present separation of fisheries targeting greater silver smelt into distinctive subareas of the North Atlantic. Target fisheries developed in these distinct subareas because aggregations of spawners were discovered, facilitating aimed benthopelagic trawling.

In the Norwegian Sea and North Sea-Skagerrak the distribution is continuous from the Skagerrak along the Norwegian Deep northwards along the Norwegian shelf to the entrance to the Barents Sea. Documented spawning areas are deep shelf troughs and upper slope waters off of mid-Norway and deeper parts of the Skagerrak, but it is likely that the species also spawns in deep Norwegian fjords. Studies of population genetics have not been conducted in the relevant areas.

A.2 Fishery

Minor target fisheries first developed in the Norwegian Deep in the Skagerrak (Division 3.a) in the 1970s (Thorsen, 1979) and was soon after followed by the currently major fishery in deep-shelf troughs and along the shelf break off of mid-Norway (ICES Division 2.a) (Monstad and Johannessen, 2003; Johannessen and Monstad, 2003). In addition, the species was always a bycatch in the industrial fisheries for Norway pout and blue whiting along the western and southern slope of the Norwegian Deep in Division 4.a and to a lesser extent 3.a, as well as in *Pandalus borealis* fishery in the same area (Lahn-Johannessen *et al.*, 1978; ICES, 2007, 201). Bycatches are landed for reduction, while target fisheries land most catches for human consumption. Discards are small.

Figure 1 illustrates typical geographical distribution of Norwegian catches in recent years, illustrated with data from 2015. All landings come from within EEZs.

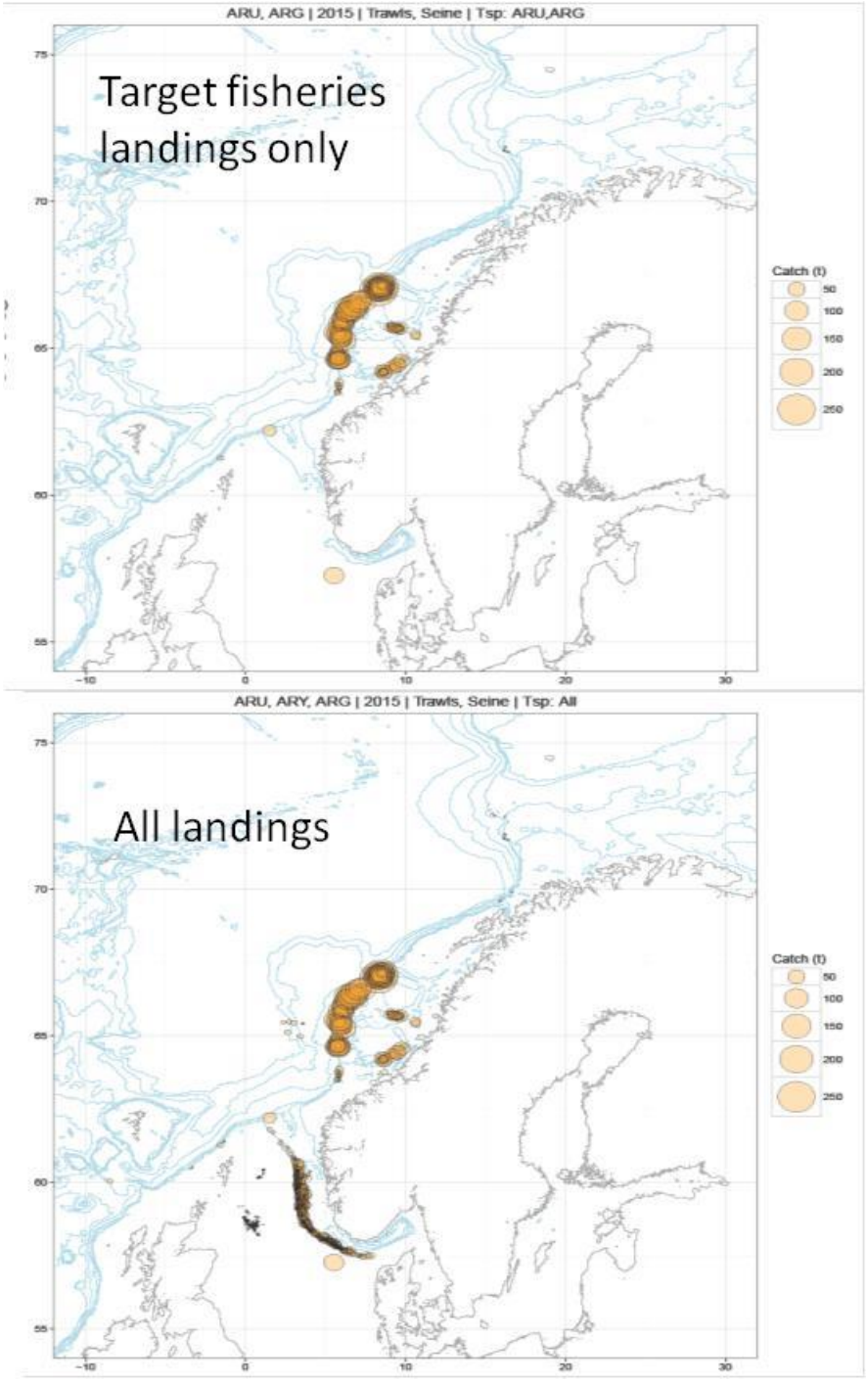

Figure 1. Norwegian greater silver smelt landings in 2015 distributed on fishing areas in the Norwegian Sea and North Sea-Skagerrak.

A.3 Ecosystem aspects

The significance of greater silver smelt in fish assemblages as well as its diets and food-web linkages were analysed in studies in the Norwegian Deep in the 1980s (Bergstad, 1990; Bergstad *et al*., 2003).

B. Data

B.1 Commercial catch

Landings from Division 3.a have been reported to WGDEEP since 1966, from the North Sea (Subarea 4) from 1970, and from Subareas 1 and 2 since 1988 (Figure 2). Norwegian landings were always dominant.

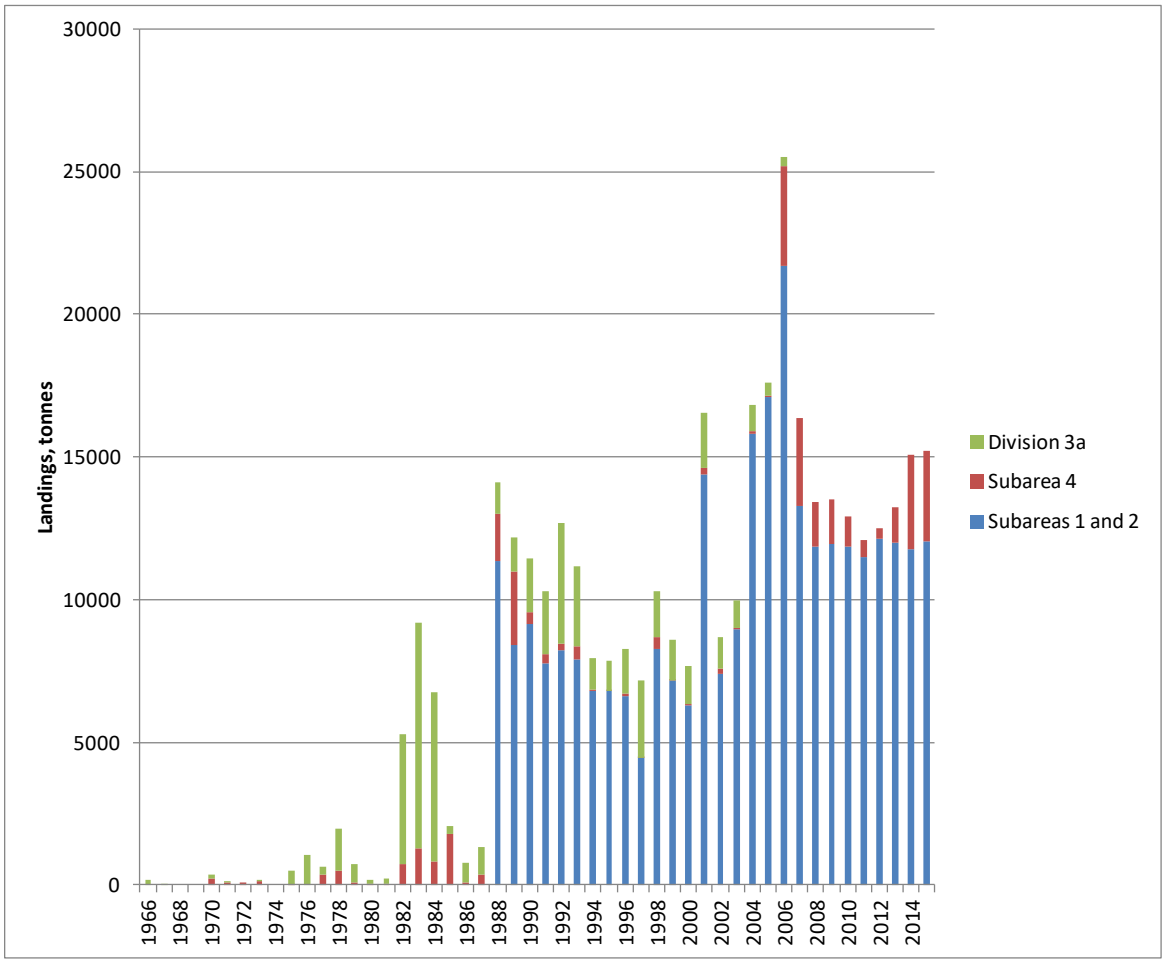

Figure 2. Landings of greater silver smelt for Subareas 1, 2, 4, and Division 3.a as reported to ICES.

B.2 Biological

A number of theses, publications and reports deal with biology and ecology of greater silver smelt in the relevant area. The first study related to fisheries was the thesis by Thorsen (1979). The distribution and biology of the species in the Norwegian Deep was described in Bergstad (1990; 1993), and occurrence of eggs and larvae in the Skagerrak by Bergstad and Gordon (1994). Bergstad (1993) showed how the species dispersed into wider areas as juveniles and during the summer and autumn. Studies from the 1980s showed that in deeper parts of the 3.a (depth >300 m), *Argentina silus* dominated the fish community together with roundnose grenadier (*Coryphaenoides rupestris)* (Bergstad, 1990; Bergstad *et al*., 2003). Extensive trawl and acoustics mapping and biological studies were also conducted in Subareas 1 and 2 in the 1980s and 1990s and published by Monstad and Johannessen (2003) and Johannessen and Monstad (2003).

Age determination methods were developed in Norway and described by Bergstad

(1993), and this formed the basis for studies of age distributions, growth, maturity ogives, and derivation of age–length keys. Such data are available for both the North Sea Skagerrak and the Norwegian Sea distribution areas.

B.3 Surveys

B.3.1 Norwegian biennial trawl–acoustic survey (Subareas 1 and 2)

The series was initiated in 2009, and surveys have been conducted in 2012, 2014 and 2016. Acoustic properties of greater silver smelt, survey and biomass estimation method was described in a working document at the last ICES benchmark on the species (Harbitz, 2010).

Distribution maps, abundance and biomass indices based on all available survey data (including sporadic surveys included in Section B.3.1.3) from Division 2 after 2003 are summarised in Figures 5 and 6.

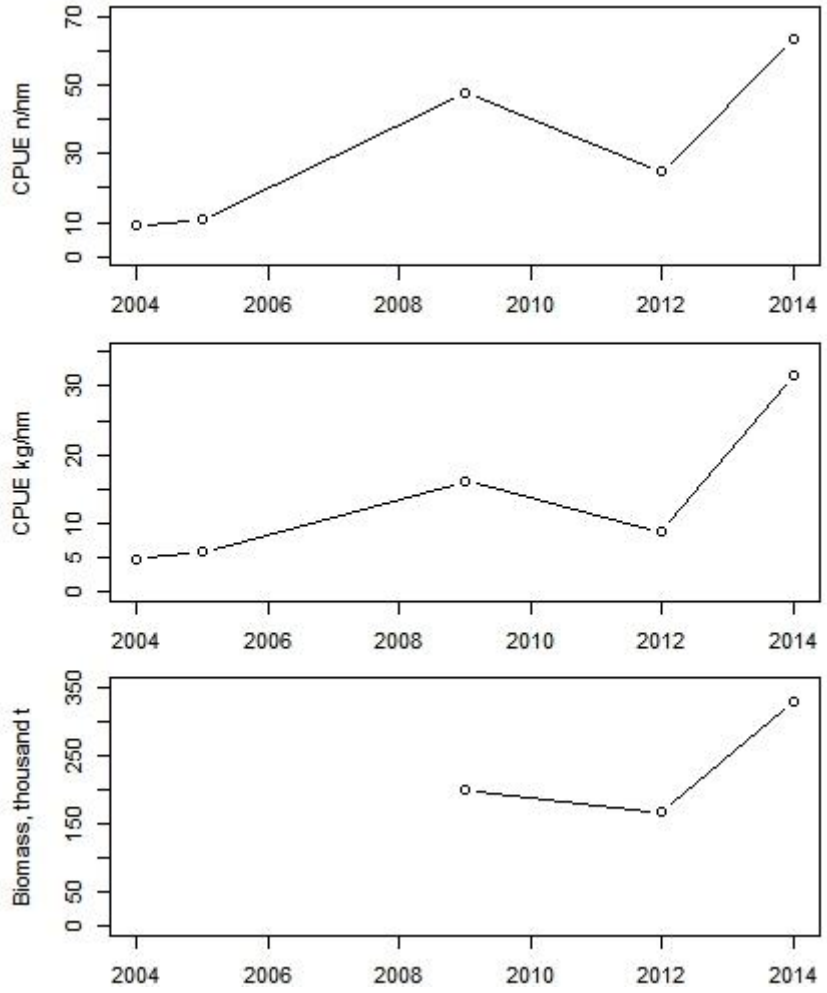

Figure 5. Abundance and biomass indices for greater silver smelt in Norwegian slope surveys (Division 2a) in March/April 2004, 2005, 2009, 2012 and 2014. The lower graph shows acoustic biomass estimates from the surveys in 2009, 2012 and 2014.

B.3.2 Norwegian shrimp survey (Division 3.a and south–eastern Division 4.a)

This series of annual bottom trawl surveys was initiated in 1984. It is a depth-stratified shrimp trawl survey with approximately 25% of the stations deeper than 300 m (depth

range 110–520 m) covering all depths and areas relevant for greater silver smelt. The trawl used has small meshes overall and a 6 mm codend liner and retains all sizes of greater silver smelt. The stations were initially placed at random within strata and sub-areas, and the same sites are sampled every year. Although some changes occurred over the years, the overall standardization was maintained throughout the time-series (Bergstad *et al*., 2014). The survey conducted in 1984 was omitted because the first survey was not yet fully standardized.

Catch rates in terms of biomass and abundance are derived (Stations with zero catches were included, and the catches at non-zero stations were standardized by tow duration).

B.3.3 Other survey data

More sporadic surveys have been conducted to map greater silver smelt, i.e. in the 1980s and 1990s (Bergstad, 1993; Monstad and Johannessen, 2003; Johannessen and Monstad, 2003). Further surveys were conducted in Division 2.a in 2003–2005. Data from these surveys were included in Figures 5 and 6.

Based on multiple surveys in the 2000s, seasonal cpue estimates were derived (Figure 7).

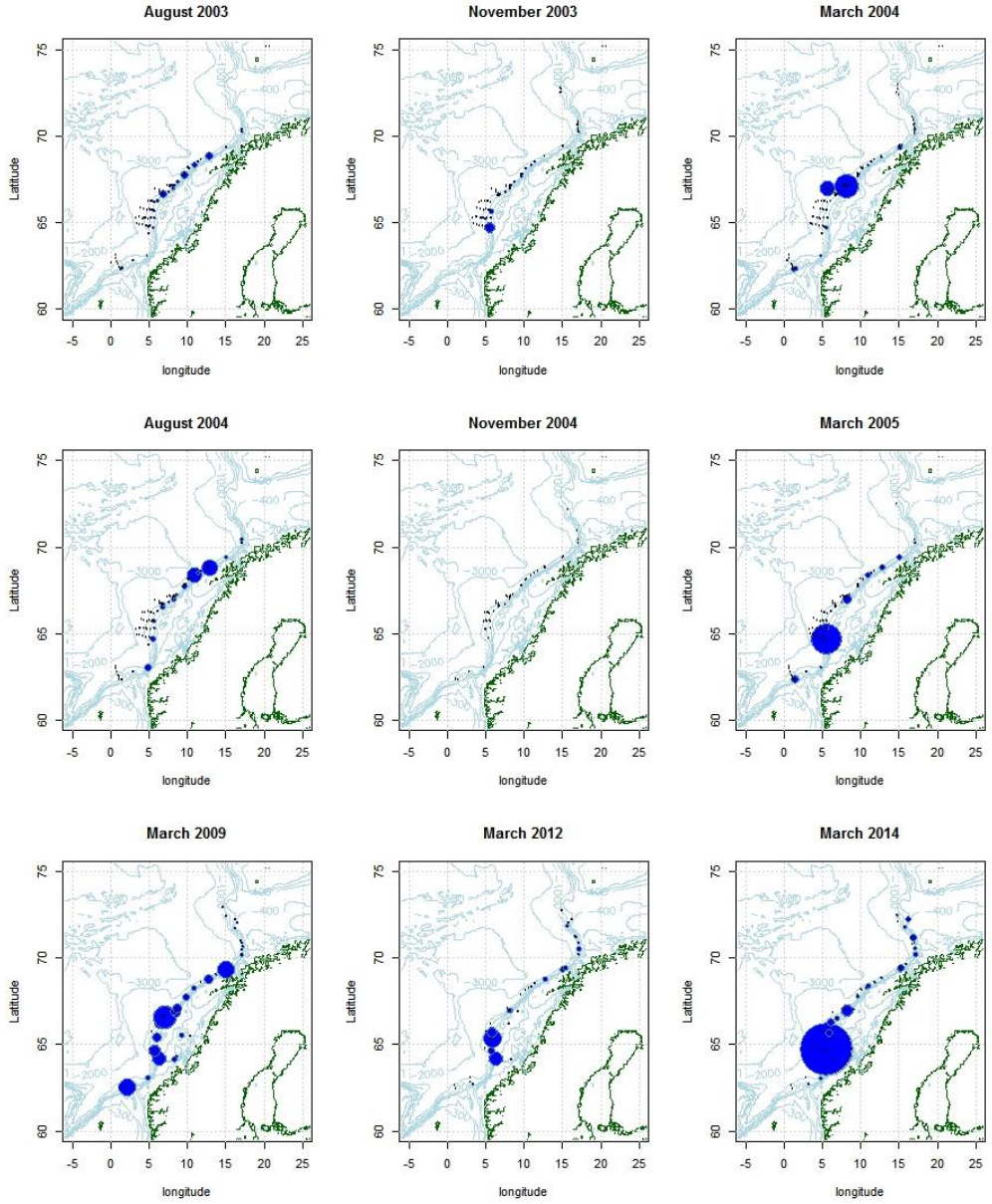

Figure 6. Norwegian survey data, greater silver smelt, 2003–2014. The three last years are included in a standardized biennial series continued in 2016.

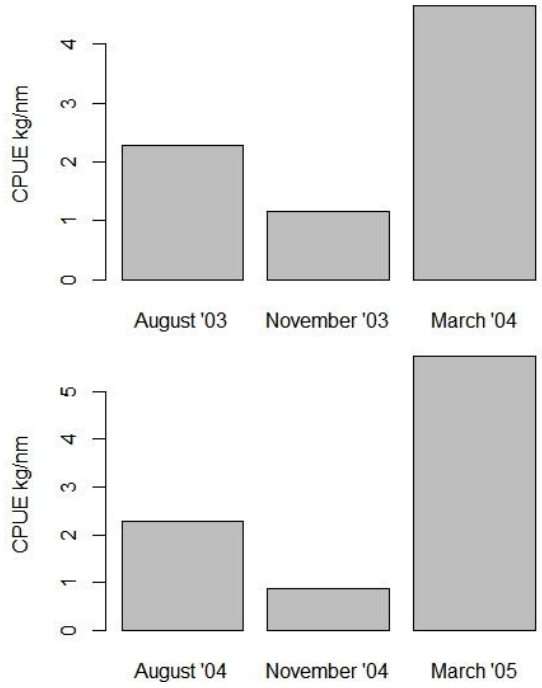

Figure 7. GSS in IIa. Trawl cpue by month in Norwegian slope surveys in 2003–2005.

B.4 Commercial cpue

No data available. The target fishery producing the bulk of the landings is targeting aggregations, to a large extent using benthopelagic trawls. Commercial cpue may not provide reliable indices of abundance.

B.5 Other relevant data

C. Assessment: data and method

Model used: Survey trends. Norwegian biennial survey for Division 2, and shrimp survey for Division 3.a.

Software used:

Model Options chosen:

Input data types and characteristics:

Type	Name	Year range	Split on countries	Variable from year to year Yes/No
Trawl-Acoustic survey	Norw. Slope survey Subareas 1 and 2	2009–2016	Norway only	Yes (biennial)
Shrimp trawl survey	Norw. Shrimp survey, Division 3.a and 4.a	1985–2016	Norway only	No

In 2015 WGDEEP applied the ICES framework for category 3 stocks (ICES, 2012), and

the Norwegian acoustic survey in Subarea 2 was applied as an index for the stock development. The advice was based on a comparison of the two latest index values (index A) with the three preceding values (index B), combined with average catches in recent years. For years, where index values were not available, the values were obtained by interpolation (Figure 8).

Index A (2013–2014)		288 173	
Index B (2010–2012)		189 705	
Index ratio (A/B)		1.52	
Uncertainty cap	Applied		1.2
Average catches (2012, 2013, 2014)		13 591	
Discard rate		Negligible	
Precautionary buffer	Applied		0.8
catch advice*		13 047	

*** (average catches × cap × buffer).**

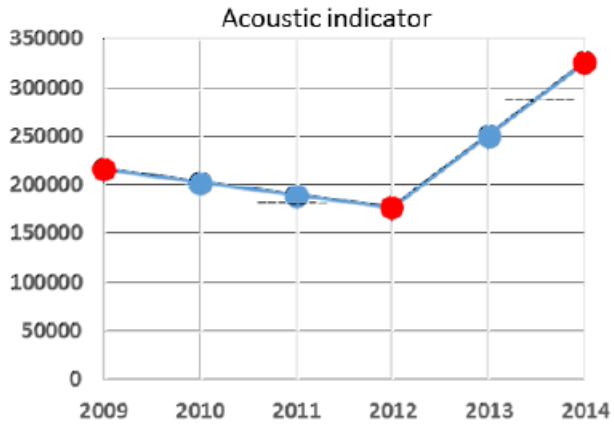

Figure 8. Acoustic indicator based on Norwegian slope surveys. Blue points were derived by interpolation.

D. Short–term projection

E. Medium–term projections

F. Long–term projections

G. Biological reference points

H. Other issues

I. References

Bergstad, O.A. 1990. Ecology of the fishes of the Norwegian Deeps: Distribution and species assemblages. *Netherlands Journal of Sea Research* 25(1/2): 237–266.

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Monstad, T., and Johannessen, A. 2003. Acoustic recordings of greater silver smelt (*Argentina silus*) in Norwegian waters and west of the British Isles, 1989–1994. Journal of Northwest Atlantic Fishery Science, 31: 339–351.

Thorsen, T. 1979. Populasjonsparametrar hos vassild, *Argentina silus,* utanfor Mør-Trøndelag og i Skagerrak. Candidatus realium thesis, Univerity of Bergen, Norway, 79p.

Table 7.2.1. Greater Silver Smelt in 1, 2, 3.a and 4 by countries. WG estimates of landings in tonnes. ICES official statistics.

year	Denmark	Sweden	Ireland	Germany	Netherlands	Norway	Poland	Russia/USSR	Scotland	France	Faroes	Iceland	SUM
1966	0	0		0		156							156
1967	0	0		0		3							3
1968	0	0		0		0							0
1969	0	0		0		0							0
1970	0	0	0	0	0	339			0	0			339
1971	0	0	0	0	0	116			0	0			116
1972	0	0	0	0	0	77			0	0			77
1973	0	0	0	21	0	110			0	0			131
1974	0	0	0	0	0	0			0	0			0
1975	0	0	0	0	0	500			0	0			500
1976	0	0	0	0	0	1034			0	0			1034
1977	0	0	0	0	0	478			0	0			478
1978	0	0	0	428	0	1500			0	0			1928
1979	0	0	0	64	0	640			0	0			704
1980	0	0	0	22	0	156			0	0			178
1981	0	0	0	18	0	183			0	0			201
1982	4654	0	0	0	0	610			0	0			5264
1983	8539	0	0	0	0	671			0	0			9210
1984	6293	0	0	0	0	442			0	0			6735
1985	996	0	0	0	0	1070			0	0			2066
1986	0	0	0	0	0	762			0	0			762
1987	190	0	0	2	0	1141			0	0			1333
1988	1062	0	0	1	0	13014	5	14	0	0	0	0	14096
1989	1322	0	0	0	335	10495	0	23	1	0	0	0	12176
1990	737	0	0	13	5	10686	0	0	0	0	0	0	11441
1991	1421	0	0	0	3	8864	0	0	6	1	0	0	10295

year	Denmark	Sweden	Ireland	Germany	Netherlands	Norway	Poland	Russia/USSR	Scotland	France	Faroes	Iceland	SUM
1992	3564	0	0	1	70	8932	0	0	101	0	0	0	12668
1993	2353	0	0	0	298	8481	0	0	56	0	0	0	11188
1994	1118	0	0	0	0	6221	0	0	614	0	0	0	7953
1995	1061	0	0	357	0	6419	0	0	20	0	0	0	7857
1996	1446	0	0	0	0	6817	0	0	0	0	0	0	8263
1997	1455	542	0	1	0	5167	0	0	0	0	0	0	7165
1998	748	428	0	169	277	8655	0	0	0	0	0	0	10277
1999	1420	0	0	0	7	7151	0	0	18	0	0	0	8596
2000	1039	273	10	0	3	6107	0	195	18	9	0	0	7654
2001	907	1011	3	0	0	14360	0	7	233	28	0	0	16549
2002	614	484	4	0	0	7406	0	0	164	0	0	0	8672
2003	918	42	0	4	617	8351	0	7	22	4	4	0	9969
2004	910	0	36	4	4277	11574	0	4	12	0	0	0	16817
2005	470	0	0	1	28	17066	0	16	0	0	14	0	17595
2006	335	0	0	6	0	25149	0	4	2	0	0	0	25496
2007	0	0	0	0	0	16373	0	1	0	0	0	0	16374
2008	0	0	0	0	0	13424	0	0	0	0	0	0	13424
2009	0	0	0	0	0	13495	0	0	0	0	0	0	13495
2010	0	0	0	0	0	12865	0	0	33	0	0	0	12898
2011	0	0	0	0	0	12060	0	0	0.4	4	0	0	12064
2012	0	0	0	0	0	12352	0	0	0	1.2	114	18	12485
2013	0	0	0	0	0	13227	0	0	0	2.3	0	0	13229
2014	40	1	0	204	345	14471	0	0	0	1	0	0	15062
2015	0	1	0	0	0	15235	0	0	0	0	0	0	15236
2016	0	1	0	38	11	18835	0	7	0	1.4	0	0	18893
2017	0	1	0	0	10	17788	0	35	0	0	0	0	17835
2018*	18	4		67	152	23609		9					23859

*Preliminary landings

Table 7.2.2. Greater Silver Smelt in 1 and 2. WG estimates of landings in tonnes.

Year	Germany	Netherlands	Norway	Poland	Russia/USSR	Scotland	France	Faroes	Iceland	TOTAL
1988			11332	5	14					11351
1989			8367		23					8390
1990		5	9115							9120
1991			7741							7741
1992			8234							8234
1993			7913							7913
1994			6217			590				6807
1995	357		6418							6775
1996			6604							6604
1997			4463							4463
1998	40		8221							8261
1999			7145			18				7163
2000		3	6075		195	18	2			6293
2001			14357		7	5				14369
2002			7405			2				7407
2003		575	8345		7	2	4	4		8937
2004		4235	11557		4					15796
2005			17063		16			14		17093
2006			21681		4					21685
2007			13272		1					13273
2008			11876							11876
2009			11929							11929

Year	Germany	Netherlands	Norway	Poland	Russia/USSR	Scotland	France	Faroes	Iceland	TOTAL
2010			11831			23				11854
2011			11476			0.4				11476
2012			12002				0.2	114	18	12134
2013			11978				0.3			11979
2014			11752							11752
2015			12049							12049
2016			13115		7		0.4			13122
2017		10	12277		35					12322
2018*	0.2	0.4	15823		8.5					15832

*Preliminary landings

Table 7.2.3. Greater Silver Smelt in 3. WG estimates of landings in tonnes. Figures in parentheses are discards as recorded in InterCatch.

Year	Denmark	Germany	Norway	Sweden	TOTAL
1966			156		156
1967			3		3
1968					
1969					
1970			106		106
1971			26		26
1972					
1973		20			20
1974					
1975			496		496
1976			1034		1034
1977			273		273
1978		25	1435		1460
1979			640		640
1980			156		156
1981			173		173
1982	4376		140		4516
1983	7733		221		7954
1984	5588		317		5905
1985	10		281		291
1986			676		676
1987	190		768		958
1988	1062		27		1089
1989	938		236		1174
1990	732		1150		1882
1991	1421		800		2221
1992	3564		634		4198
1993	2343		487		2830
1994	1108				1108
1995	1061				1061
1996	1389		159		1548
1997	1455		703	542	2700
1998	748		413	428	1589
1999	1420		2		1422
2000	1039		4	273	1316
2001	907			1011	1918
2002	614			484	1098
2003	918			42	960
2004	910		1		911
2005	470				470
2006	324				324
2007					0

Year	Denmark	Germany	Norway	Sweden	TOTAL
2008					0
2009					0
2010					0
2011					0
2012					0
2013					0
2014			2	1	3
2015			22	1	23
2016			101	1	102
2017			3	(1)	3(1)
2018*				(3.6)	(3.6)

***Preliminary landings**

Table 7.2.4. Greater Silver Smelt in 4. WG estimates of landings in tonnes. Figures in parentheses are discards as recorded in InterCatch.

Year	Denmark	France	Germany	Netherlands	Norway	Scotland	Ireland	Russia	TOTAL
1970					233				233
1971					90				90
1972					77				77
1973			1		110				111
1974									
1975					4				4
1976									
1977					205				343
1978			403		65				493
1979			64						64
1980			22						22
1981			18		10				28
1982	278				470				748
1983	806				450				1256
1984	705				125				830
1985	986				789				1775
1986					86				86
1987			2		373				375
1988			1		1655				1656
1989	384			335	1892	1			2612
1990	5		13		421				439
1991		1		3	323	6			333
1992			1	70	64	101			236
1993	10			298	81	56			445
1994	10				4	24			38
1995					1	20			21
1996	57				54				111
1997			1		1				2
1998			129	277	21				427
1999				7	4				11
2000		7			28		10		45
2001		28			3	228	3		262
2002					1	162	4		167
2003			4	42	6	20			72
2004			4	42	16	12	36		110
2005			1	28	3				32
2006	11		6		3468	2			3487
2007					3101				3101
2008					1548				1548
2009					1566				1566
2010					1034	10			1044
2011		4			584				588

Year	Denmark	France	Germany	Netherlands	Norway	Scotland	Ireland	Russia	TOTAL
2012		1			350				351
2013		2			1249				1251
2014	40 (7)	1	204	345	2717				3307(7)
2015					3164				3164
2016		1	38	11	5619				5669
2017					5508	(388)			5508(388)
2018*	17(1)		67	152	7786	(38)		6	8028(39)

***Preliminary landings**