

## 5.4.21 Cod in Division VIa (West of Scotland)

### State of the stock

Spawning biomass in relation to precautionary limits	Fishing mortality in relation to precautionary limits	Fishing mortality in relation to highest yield	Fishing mortality in relation to agreed target	Comment
Reduced reproductive capacity	Unknown	Unknown	Not defined	Total mortality cannot be accurately partitioned into fishing mortality and natural mortality

Based on the most recent estimates of SSB (in 2008) ICES classifies the stock as suffering reduced reproductive capacity. Total mortality is probably high but cannot be accurately partitioned into fishing mortality and natural mortality. The spawning-stock biomass has increased from an all time low in 2006 but remains well below  $B_{lim}$ . Recruitment has been estimated to be low over the last decade. The 2005 year class is estimated to be the largest for that decade, but still below the long-term average.

### Management objectives

The European Commission has enacted a Council Regulation ((EC) No. 423/2004) which establishes measures for the recovery of cod stocks:

*For stocks above  $B_{lim}$ , the harvest control rule (HCR) requires:*

1. *setting a TAC that achieves a 30% increase in the SSB from one year to the next,*
2. *limiting annual changes in TAC to  $\pm 15\%$  (except in the first year of application), and,*
3. *a rate of fishing mortality that does not exceed  $F_{pa}$ .*

*For stocks below  $B_{lim}$  the Regulation specifies that:*

1. *conditions 1-3 will apply when they are expected to result in an increase in SSB above  $B_{lim}$  in the year of application,*
2. *a TAC will be set lower than that calculated under conditions 1-3 when the application of conditions 1-3 is not expected to result in an increase in SSB above  $B_{lim}$  in the year of application.*

The European Commission has adopted a proposal in April 2008 to amend the EU cod recovery plan (COM(2008) 162 final).

ICES has previously concluded that a precautionary recovery plan must include an adaptive element implying that fisheries for cod remain closed until an initial recovery of the cod SSB has been proven. Such an element of zero catch is not included in the existing plan. ICES therefore considers the recovery plan to be not consistent with the precautionary approach.

### Reference points

	Type	Value	Technical basis
Precautionary approach	$B_{lim}$	14 000 t	$B_{lim} = B_{loss}$ , the lowest observed spawning stock estimated in previous assessments.
	$B_{pa}$	22 000 t	This is considered to be the minimum SSB required to ensure a high probability of maintaining SSB above $B_{lim}$ , taking into account the uncertainty of assessments. This also corresponds with the lowest range of SSB during the earlier, more productive historical period.
	$F_{lim}$	0.8	Fishing mortalities above this have historically led to stock decline.
	$F_{pa}$	0.6	This F is considered to have a high probability of avoiding $F_{lim}$ .
Targets	$F_v$	Not defined.	

*(unchanged since: 1998)*

## Single-stock exploitation boundaries

### *Exploitation boundaries in relation to existing management plans*

The management plan is not explicit about the level of reduction in the catch when the stock is below  $B_{lim}$ . Furthermore, due to the uncertainty in the level of fishing mortality, ICES is not in a position to give quantitative forecasts. Simulations conducted in 2006 showed that fishing should be closed for 3 years in order to bring SSB above  $B_{lim}$ .

### *Exploitation boundaries in relation to precautionary considerations*

Given the low SSB and low recruitments in recent years, it is not possible to identify any non-zero catch which would be compatible with the precautionary approach.

## Short-term implications

Because of uncertainties in the level and trend of natural mortality it is not possible to partition F from other sources of mortality. A short-term forecast was performed to consider projections of SSB under different levels of removals. Even under the option of zero removals SSB was predicted to still be below  $B_{lim}$  in 2010.

## Management considerations

Cod is taken in mixed demersal fisheries, and in Division VIa it is now regarded as a bycatch species. Following the advice for zero catch of cod will likely result in having to greatly reduce harvesting of other stocks such as haddock, whiting, and anglerfish. Results from the STECF meeting on the assessment of the fishing effort regime (STECF, 2007a) showed bycatch of cod from vessels targeting *Nephrops* to have declined to a low level in recent years. The amount of bycatch from this fleet needs to continue to be monitored (including discard observations) in case of a future increase in catch of cod from vessels targeting *Nephrops*.

The most recent (2005) data available on landings by ICES statistical rectangle show that all significant landings come from statistical rectangles west of the 'west of Scotland management line', or from rectangles bisected by that line. It is therefore possible that the majority of cod landings from Division VIa could be from vessels unaffected by cod recovery measures and unrestricted in their catch composition. It is important that cod recovery measures include all areas occupied by the depleted stock.

There are indications that because of new legislation, misreporting has reduced from the beginning of 2006 (see Regulations and their effects below). Fishery discard data show increased discards at ages one and two and a change in discard practices such that fish are discarded at older ages. This suggests the legislation has controlled landings rather than catch. It is important that good observer coverage is provided in Division VIa to record discard trends in future.

### *Management plan evaluations*

Simulations conducted by ICES (2006) showed that, starting in 2007, the fishery would need to be closed for 3 years in order to bring SSB above  $B_{lim}$  with high probability.

### *Impacts of fisheries on the ecosystems*

For a general description of the impacts of the demersal trawl fishery in ICES Division VIa see the overview. Cod is taken in mixed demersal fisheries and there are no impacts specific to the catching of cod.

## Factors affecting the fisheries and the stock

### *Regulations and their effects*

The fishery is managed by a combination of TAC, area closures, technical measures, and effort restrictions. These do not seem to have been effective in controlling catches or sufficient to rebuild the stock to precautionary levels.

### Area closures

- Clyde Sea area closure – STECF (2007b) noted that the Clyde closure includes the main spawning area of a reproductively isolated aggregation of cod and concluded that the closure is likely to have a positive effect in reducing targeting of high densities of mature cod.

- Windsock closed area – STECF (2007b) concluded that the extent of the Windsock closure is unlikely to be large enough to greatly reduce fishing mortality on cod, and its boundaries should be reconsidered. However, its removal would not help improve cod recovery.

#### Mesh sizes

- Change from 100 to 120 mm for vessels fishing for cod (Reg. (EC) 2056/2001) – The increase in minimum mesh size from 100 to 120 mm caused vessels to shift from the whitefish to the *Nephrops* targeted fishing sector. This resulted in an increase in effort using 80 mm mesh.

#### Effort limitations

- Days-at-sea allowances currently implemented under Annex IIa of Reg. (EC) 40/2008 – The restrictions are targeted primarily at gears taking the largest catches of cod. For gears with mesh sizes of 70–89 mm and 90–99 mm this has led to days-at-sea limits between two and three times greater than the limits for gears with mesh sizes of 100–119 mm or  $\geq 120$  mm. The introduction of effort regulation has effectively further encouraged vessel operators to reduce mesh size and shift to other fisheries, particularly *Nephrops* trawling, in order to gain more days at sea.
- Catch composition rules related to days-at-sea allowances (Reg. (EC) 850/1998 Annex I and Reg. (EC) 2056/2001) – These rules legislate for landings compositions but do not restrict discards.

#### Supply chain traceability

- U.K. “Buyers and Sellers” regulation and Irish “Sales Note” regulation – Unreported landings are expected to have reduced under these regulations. Observer data, however, show an increase in discards starting in 2006. The amount of discards relative to landings has increased and the age pattern of discarding has changed. Currently discards of fish aged 3 and above are being recorded.

In Scotland the ‘Conservation Credits Scheme’ was implemented from the beginning of February 2008 and essentially grants vessels their 2007 allocation of days (operated as hours at sea) in return for observance of measures to avoid cod catch. Adherence to the measures under this scheme is not mandatory and it is too early for ICES to comment on the success of the measures in aiding cod recovery.

#### *Changes in fishing technology and fishing patterns*

In 2007 there has been a shift away from the traditional whitefish fishery in ICES Division VIa and into the *Nephrops* fishery in Division IVa by vessels that were using 100–110 mm mesh west of Scotland.

Rising fuel costs are influencing the choice of gear deployed. There have been instances of changes from twin trawl to single trawl and an increase in the use of pair trawl/seine.

Some vessels operating in the Division VIa *Nephrops* fleet have adopted a 100–110 mm square mesh panel. This gives a theoretical 10% increase in the mean length of cod captured. However, to be most effective the square mesh panel should be installed close to the codend of the net, whereas some of the installed square mesh panel have been placed some distance from the codend.

There has been some reduction in the number of Irish vessels as a result of decommissioning.

#### *Impacts of the environment on the fish stock*

ICES (2008) reported on the general warming trend of the Northern Shelf waters. A negative impact on recruitment with rising sea temperature has been shown for cod in the warmer waters of this species’ range, including cod west of Scotland (Brunel and Boucher, 2007).

Seal abundance has increased west of Scotland over the recent decades. Seals are known to feed on cod, amongst other species, and the mortality of cod due to seal predation is likely to have increased in recent years. However, the contribution of seal predation to total cod mortality is not known.

## Scientific basis

### *Data and methods*

A catch-at-age model using catch data up to 1994 tuned by survey data and utilizing survey information alone from 1995 onward was used to evaluate trends in spawning-stock biomass and recruitment. Trends in SSB are similar to the results obtained from a model based on survey data alone. Estimates of mortality are those from total removals, i.e. fishing mortality plus unaccounted mortality. Discards-at-age data are provided by Scotland only.

### *Uncertainties in assessment and forecast*

Landings data are considered to be very uncertain, due to incorrect reporting of landings (species and quantity). There are indications that misreporting has reduced from the beginning of 2006. In the current set-up of the assessment model discard information is removed for the same years for which landings data is removed. The increase in discards at ages one and two in 2006 and 2007 is not accounted for in the assessment.

Survey information shows that the total removal of cod in Division VIa may have been underestimated in the past decade relative to earlier periods. In an attempt to remove bias in the assessment a catch-at-age model was used that ignored landings and discard numbers from 1995 onwards, relying on survey data for this later period. It is, however, considered that mortality estimates arising from this assessment heavily or wholly based on survey data are poorly estimated. In contrast, historical trends in spawning biomass and recruitment appear to be robust measures of stock dynamics, see Figure 5.4.21.3.

Only a single survey series is considered of sufficient quality for use in the assessment and the values of the indices have high variability. This causes estimation of mortality-at-age to be uncertain in particular. Because of uncertainties in the level and trend of natural mortality it is not possible to predict landings estimates from the forecast, only removals associated with both fishing and unaccounted natural mortality.

### *Comparison with previous assessment and advice*

The perception of the state of the stock remains unchanged. Although recruitment of the 2005 year class has been revised upwards and the strength of this year class has resulted in estimated SSB increasing from 2006 to 2007 and again from 2007 to 2008, forecasts still put SSB below  $B_{lim}$  in 2009 and 2010. The advice is the same as last year.

## Sources of information

Report of the Working Group on the Assessment of Northern Shelf Demersal Stocks, 15-21 May 2008 (ICES CM 2008/ACOM:08).

Brunel, T., and Boucher, J. 2007. Long-term trends in fish recruitment in the north-east Atlantic related to climate change. *Fisheries Oceanography*, 16(4): 336–349.

Hammond, P. S., and Harris, R. N. 2006. Grey seal diet composition and prey consumption off western Scotland and Shetland. Final report to Scottish Executive Environment and Rural Affairs Department and Scottish Natural Heritage.

ICES. 2006. Report of the Working Group on the Assessment of Northern Shelf Demersal Stocks (WGNSDS), 9–18 May 2006, ICES Headquarters, Denmark. ICES CM 2006/ACFM:30. 870 pp.

ICES. 2008. Report of the Working Group for Regional Ecosystem Description (WGRED), 25–29 February 2008, ICES, Copenhagen, Denmark. ICES CM 2008/ACOM:47. 203 pp.

STECF. 2007a. STECF sub group SGRST on Fishing Effort Regime, Lisbon 21–25 June 2007 and Ispra, 24–28 September 2007.

STECF. 2007b. Evaluation of closed area schemes (SGMOS-07-03).

Year	ICES advice	Single-stock exploitation boundaries	Predicted catch corresp. to advice	Predicted catch corresp. to single-stock boundaries	Agreed TAC <sup>1</sup>	Official landings	ICES Landings
1987	Reduce F towards $F_{max}$		18.0		22.0	19.2	19.0
1988	No increase in F; TAC		16.0		18.4	19.2	20.4
1989	80% of F(87); TAC		16.0		18.4	15.4	17.2
1990	80% of F(88); TAC		15.0		16.0	11.8	12.2
1991	70% of effort (89)		-		16.0	10.6	10.9 <sup>2</sup>
1992	70% of effort (89)		-		13.5	9.0	9.7 <sup>3</sup>
1993	70% of effort (89)		-		14.0	10.5	11.8 <sup>3</sup>
1994	30% reduction in effort		-		13.0	9.1	10.8 <sup>3</sup>
1995	Significant reduction in effort		-		13.0	9.7	9.6 <sup>3</sup>
1996	Significant reduction in effort		-		13.0	9.6	9.4
1997	Significant reduction in effort		-		14.0	7.0	7.0
1998	20% reduction in F		9.5 <sup>5</sup>		11.0	5.7	5.7
1999	F reduced to below $F_{pa}$		<9.7 <sup>5</sup>		11.8	4.3	4.2
2000	Recovery plan, 60% reduction in F		<4.2		7.48	2.8 <sup>4</sup>	3.0
2001	Lowest possible F, recovery plan		-		3.7	2.5	2.3
2002	Recovery plan or lowest possible F		-		4.6	2.0	2.1
2003	Closure		-		1.81	1.3	n/a
2004		Zero catch	<sup>6</sup>	0	0.85	0.6	n/a
2005		Zero catch	<sup>6</sup>		0.72	0.5	n/a
2006		Zero catch	<sup>6</sup>		0.613	0.5	n/a
2007		Zero catch	<sup>6</sup>	0	0.49	0.5	n/a
2008		Zero catch	<sup>6</sup>	0	0.402		n/a
2009		Zero catch	<sup>6</sup>	0			

Weights in '000 t.

<sup>1</sup>TAC is for the whole of Subdivision Vb<sub>1</sub> and Subareas VI, XII, and XIV.

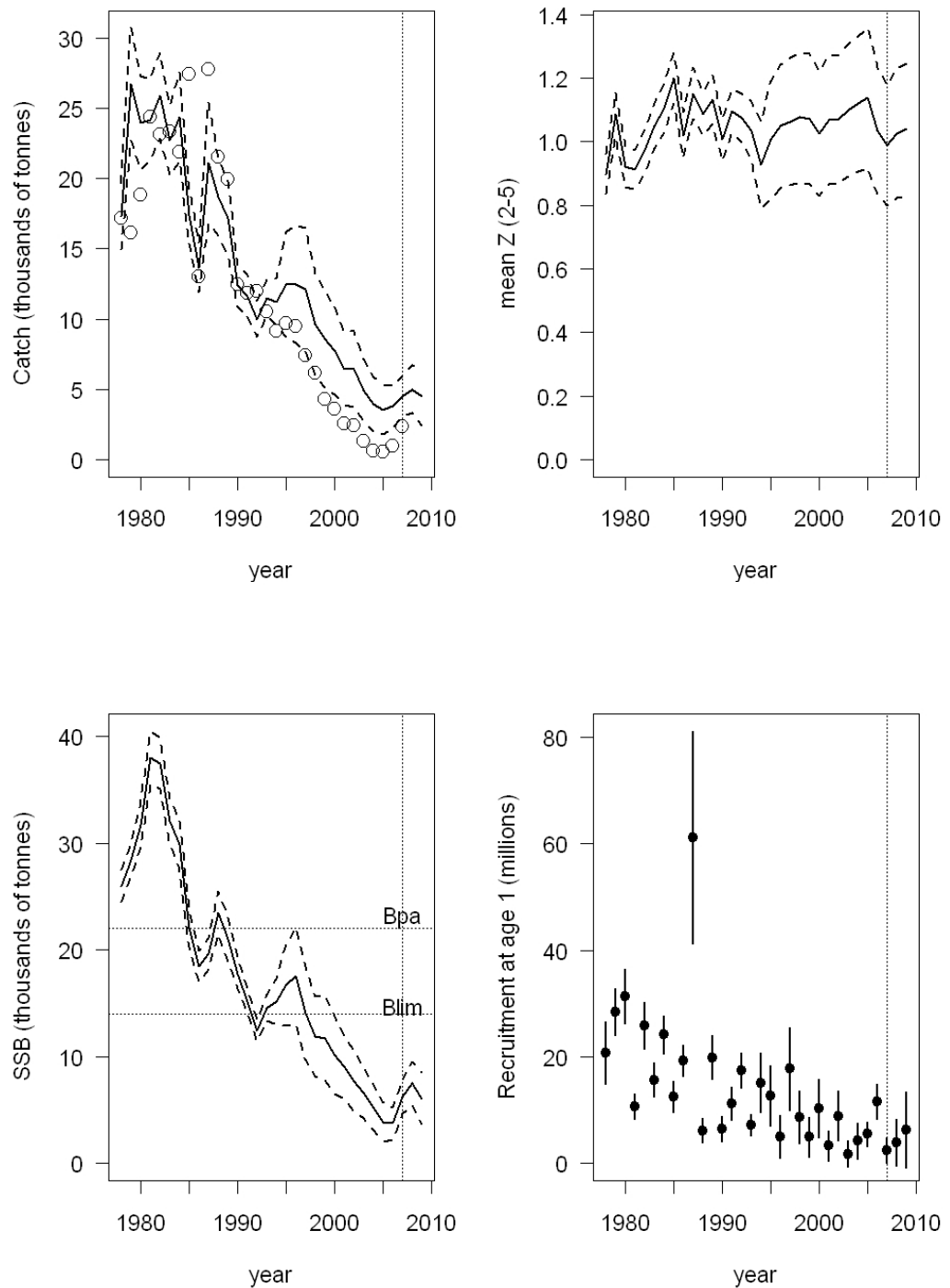
<sup>2</sup>Not including misreporting.

<sup>3</sup>Including ICES estimates of misreporting.

<sup>4</sup>Incomplete data.

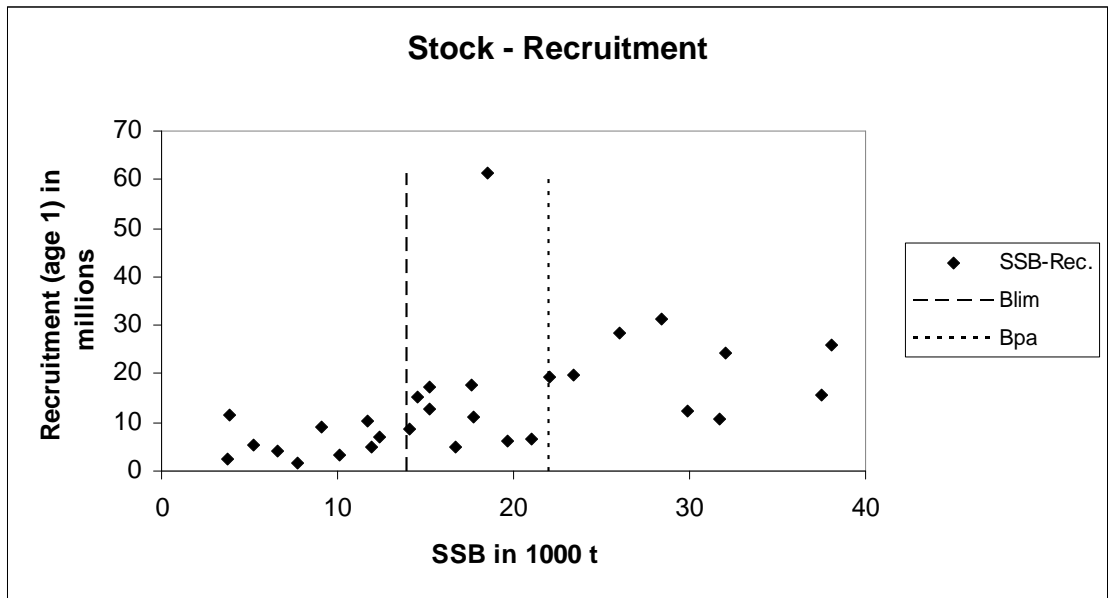
<sup>5</sup>For Division VIa only.

<sup>6</sup>Single-stock boundaries and the exploitation of this stock should be conducted in the context of mixed fisheries protecting stocks outside safe biological limits.

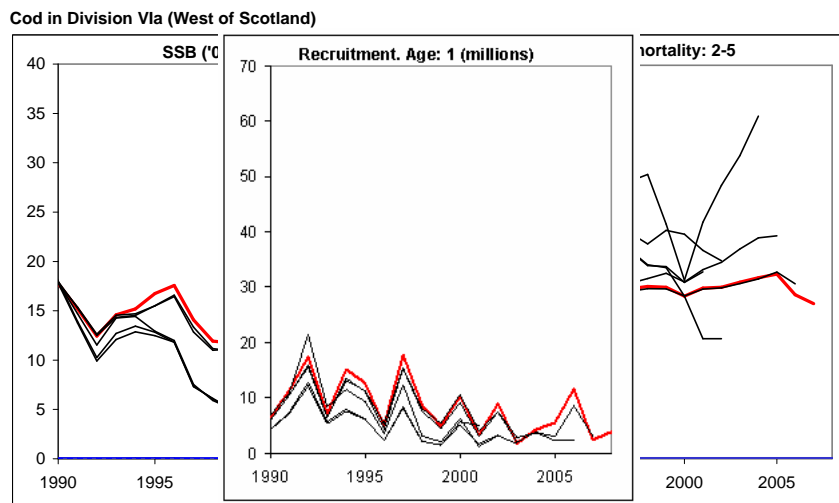


**Figure 5.4.21.1**

Cod in Division VIa. Summary plot of TSA final run (landings and discard data excluded from 1995 onward). In the catch figure, open circles indicate observed catches, and lines indicate estimated removals. Estimates are plotted with approximate point-wise 95% confidence bounds. The vertical line in each plot delineates the last year of the historical assessment (2007); estimates to the right of these lines are the TSA-based forecast using *status quo* removal.



**Figure 5.4.21.2** Cod in Division VIa. Stock and recruitment relationship.



**Figure 5.4.21.3** Cod in Division VIa. Comparison of current assessment with previous assessments (SSB and recruitment only).





**Table 5.4.21.1** Cod in Division VIa. Official catch statistics in 1985–2007, as reported to ICES.

Country	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Belgium	48	88	33	44	28	-	6	-	22	1	2	+	11	1	+	+	2	+
Denmark	-	-	4	1	3	2	2	3	2	+	4	2	-	-	+	-	-	-
Faroe Islands	-	-	-	11	26	-	-	-	-	-	-	-	-	-	-	-	-	-
France	7,411	5,096	5,044	7,669	3,640	2,220	2,503	1,957	3,047	2,488	2,533	2,253	956	714*	842*	236	391	208
Germany	66	53	12	25	281	586	60	5	94	100	18	63	5	6	8	6	4	+
Ireland	2,564	1,704	2,442	2,551	1,642	1,200	761	761	645	825	1,054	1,286	708	478	223	357	319	210
Netherlands	-	-	-	-	-	-	-	-	-	-	-	-	2	1	-	-	-	-
Norway	204	174	77	186	207	150	40	171	72	51	61	137	36	36	79	114*	40*	88
Spain	28	-	-	-	85	-	-	-	-	-	16	+	6	42	45	14	3	11
UK (E., W., N.I.)	260	160	444	230	278	230	511	577	524	419	450	457	779	474	381	280	138	195
UK (Scotland)	8,032	4,251	11,143	8,465	9,236	7,389	6,751	5,543	6,069	5,247	5,522	5,382	4,489	3,919	2,711	2,057	1,544	1,519
UK																		
Total landings	18,613	11,526	19,199	19,182	15,426	11,777	10,634	9,017	10,475	9,131	9,660	9,580	6,992	5,671	4,289	2,767	2,439	2,231

Country	2003	2004	2005	2006	2007*
Belgium					
Denmark					
Faroe Islands		2	0	1	12
France	172	91	107	101	81
Germany	+			2	2
Ireland	120	34	28	18	70
Netherlands	-				
Norway	45	10	17	30	30
Spain	3				
UK (E., W., N.I.)	79	46	25		9
UK (Scotland)	879	413	243		274
UK				332	
Total landings	1,298	596	420	484	479

\* Preliminary.

**Table 5.4.21.2** Cod in Division VIa (West of Scotland).

Year	Recruitment Age 1 thousands	SSB tonnes	Total Removals tonnes	Mean Z Ages 2–5
1978	20720	26005	17352	0.898
1979	28456	28436	26738	1.085
1980	31326	31744	23974	0.921
1981	10592	38026	24197	0.913
1982	25884	37448	25934	0.972
1983	15657	32041	22750	1.049
1984	24168	29908	24424	1.104
1985	12488	22060	17379	1.201
1986	19214	18469	13670	1.019
1987	61243	19681	21148	1.151
1988	6170	23462	18700	1.088
1989	19870	21013	17178	1.132
1990	6466	17745	12368	1.007
1991	11286	15214	11670	1.097
1992	17407	12441	10005	1.075
1993	7188	14588	11530	1.035
1994	15154	15183	11208	0.926
1995	12681	16741	12468	1.006
1996	5008	17576	12495	1.049
1997	17766	14073	12106	1.063
1998	8727	11920	9609	1.076
1999	4933	11748	8561	1.071
2000	10315	10163	7759	1.026
2001	3288	9040	6465	1.067
2002	8915	7732	6418	1.071
2003	1793	6570	4925	1.097
2004	4250	5275	3936	0.920
2005	5487	3829	3544	0.938
2006	11600	3742	3769	0.833
2007	2377	6276	4499	0.788
2008	3877	7470		
Average	14010	17278	13559	0.849