ICES COOPERATIVE RESEARCH REPORT

RAPPORT DES RECHERCHES COLLECTIVES

NO. 255

Report of the ICES Advisory Committee on Fishery Management, 2002

Copenhagen, 21 May – 30 May 2002
Copenhagen, 9 October – 17 October 2002

PART 3

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

Palægade 2–4 DK-1261 Copenhagen K Denmark

December 2002

ICES Cooperative Research Report No. 255

ISSN [redacted] 2707-7144
ISBN [redacted] 978-87-7482-409-1

3.13 Deepwater fisheries resources south of 63ºN

3.13.1 Overview

1. Background

In some parts of the northeast Atlantic where the continental shelf is narrow, such as off Portugal (including Madeira and the Azores), there are traditional fisheries, for example for black scabbardfish (*Aphanopus carbo*) and red (=blackspot) seabream (*Pagellus bogaraveo*), which have been exploiting deepwater species for many years. Other traditional species are ling, blue ling, and tusk, which have supported large fisheries in wide areas for several decades. The existence of other potentially exploitable stocks in the ICES area has been known since the 1960s and 1970s. However, before the 1980s, with the exception of a fishery for species such as roundnose grenadier (*Coryphaenoides rupestris*) there was little interest from the fishing industry in exploiting stocks in international waters.

Since the 1980s, dwindling resources on the continental shelves of the North Atlantic have encouraged the development of fisheries in deeper waters. There has been a tendency for fisheries for species such as anglerfish and Greenland halibut to extend into deeper waters, and new fisheries have developed to target the new deepwater species that have been found there. Deepwater species such as the argentine or greater silver smelt (*Argentina silus*) and roundnose grenadier (*Coryphaenoides rupestris*), which were previously by-catch species have been targeted within the ICES area for the last two decades. Orange roughy (*Hoplostethus atlanticus*) has been a target species since the early 1990s.

While there has been increasing research activity in deep water it is of concern that fisheries on deep water species have developed rapidly and that the resources, which they exploit are generally especially vulnerable to overfishing. Also within the ICES area species/stocks have been depleted before appropriate management measures have been implemented. It is also of concern that the landings statistics that are available may not reflect the true scale of the recent fishing activity in waters outside the national EEZs.

Data availability

It continues to be a major problem for the assessment of stock status that data on landings and particularly fishing effort are limited or of relatively poor quality. Furthermore, for a range of species, effort data from major fisheries could not be updated, or directed effort data were not available for the most recent years. This prevents new assessments from being carried out for some stocks, and results from assessments using total effort may not necessarily be consistent with results reported in 2000. It must be noted that this deterioration of the available data occurred at the same time as some deepsea fisheries seemed to be expanding rapidly.

The smallest units for which data are reported at present are the ICES Subareas and Divisions. The depth range within such areas may be very wide and the size of the areas varies. Furthermore, several species show relatively isolated concentrations/sub-units of a stock and catch rates can only be maintained by sequential depletion of these concentrations. Therefore, effort and catches must be recorded at a finer temporal and geographical scale.

There is also a need to collect information on length composition of landings by species, and discard sampling programs need to be developed.

Considerable progress has been made on the collection of biological data, including age determination and length-at-age data, and it is recommended to pursue such scientific investigations.

2. The species

The term deep water is defined to include waters of depths greater than 400 m. The following were identified as some of the most important deepwater species:

DEEPWATER SPECIES LIST

Alepocephalus bairdii	Baird's smoothhead
Aphanopus carbo	Black scabbardfish
Argentina silus	Argentine, greater silver smelt
Beryx splendens	Golden eye perch
Beryx decadactylus	Red bream, alfonsino
Brosme brosme	Tusk
Chimaera monstrosa	Rabbitfish
Coryphaenoides rupestris	Roundnose grenadier
Epigonus telescopus	Big eye, deepwater cardinal fish
Helicolenus dactylopterus	Bluemouth
Hoplostethus atlanticus	Orange roughy
Hoplostethus mediterraneus	Silver roughy
Lepidopus caudatus	Silver scabbardfish
Macrourus berglax	Roughhead grenadier
Molva molva	Ling
Molva dypterygia	Blue ling
Mora moro	Mora
Pagellus bogaraveo	Red (=blackspot) seabream
Phycis blennoides	Greater forkbeard
Polyprion americanus	Wreckfish
Trachyrhynchus trachyrhynchus	Roughnose grenadier
Chaecon (Geryon) affinis	Deepwater red crab
Aristeomorpha foliacea	Giant red shrimp
	Sharks, various

The main shark species caught in deepwater fisheries are:

Centrophorus granulosus	Gulper shark
Centrophorus squamosus	Leafscale gulper shark
Centroscyllium fabricii	Black dogfish
Centroscymnus coelolepis	Portuguese dogfish
Centroscymnus crepidater	Longnose velvet dogfish
Dalatias licha	Kitefin shark
Deania calcea	Birdbeak dogfish
Etmopterus princeps	Great lantern shark
Etmopterus spinax	Velvetbelly
Scymnodon ringens	Knifetooth dogfish

Advice on some other species, which might be considered as deepwater species, is already provided elsewhere in the ACFM report:

Micromesistius poutassou	Blue whiting
Reinhardtius hippoglossoides	Greenland halibut
Sebastes spp	Redfish

In addition, there are other species which have been fished on the continental shelf, but whose distribution extends into deeper waters. This group includes hake (*Merluccius merluccius*), anglerfish (*Lophius* spp.), megrim (*Lepidorhombus* spp.), and conger (*Conger conger*), and recent years have seen an extension of fishing into deeper waters for these species in ICES Subareas VI, VII, VIII, and IX. Advice is provided on these species elsewhere in the ACFM report.

3. Descriptions of deepwater fisheries by Subarea

In ICES Subarea II there are directed longline and gillnet fisheries for ling and tusk. Bottom and pelagic trawl fisheries target argentine (*Argentina silus*), and there is a minor fjord fishery for roundnose grenadier. Landings of argentine rose sharply in 2001. Roughhead grenadier are taken as by-catch in the trawl, gillnet, and longline fisheries for Greenland halibut and redfish.

In ICES Subarea III there is a targeted trawl fishery for roundnose grenadier and argentine. These species are also a by-catch of the *Pandalus* and *Nephrops* fisheries, and probably only a minor part of this by-catch is landed.

In ICES Subarea IV there is a by-catch of argentine from the industrial trawl fishery. A longline fishery targets tusk and ling with forkbeard (*Phycis blennoides*) and some roughhead grenadier as a by-catch. Some deepwater species are landed as a by-catch in the trawl fisheries targeting anglerfish and Greenland halibut.

In ICES Subarea V there are trawl fisheries which target blue ling, redfish, argentine, and occasionally orange roughy. By-catch species are typically roundnose grenadier, roughhead grenadier, black scabbardfish, anglerfish, bluemouth (*Helicolenus dactylopterus*), mora (*Mora moro*), greater forkbeard (*Phycis blennoides*), argentine, deepwater cardinal fish (*Epigonus telescopus*) and rabbit fish (*Chimaera monstrosa*). There are traditional longline fisheries for ling and tusk and these species are also by-catches in trawl and gillnet fisheries. There are also targeted trawl and gillnet fisheries for Greenland halibut and anglerfish, which have a deepwater by-catch of, for example, deepwater red crab (*Chaceon affinis*). There have also been trap fisheries for the deepwater red crab.

In ICES Subareas VI and VII there are directed trawl fisheries for blue ling, roundnose grenadier, orange roughy, black scabbard fish, and the deepwater sharks *Centroscymnus coelolepis* and *Centrophorus squamosus*. By-catch species include bluemouth, mora, greater forkbeard, argentine, deepwater cardinal fish, and chimareids, of which *Chimaera monstrosa* is the most important. The orange roughy landings doubled from 2000 to 2001, most of them coming from Subarea VII. The argentine and blue ling landings increased, the former reflecting increasing target fishery. By-catch species include bluemouth, mora, greater forkbeard, argentine, deep-sea cardinal fish, and chimaerids (mostly *Chimera monstrosa*). There are directed longline fisheries for ling and tusk and also for hake, often with deepwater sharks as a by-catch. There are targeted fisheries for sharks in Subareas VI and VII and a gillnet fishery in Subarea VII for ling.

In ICES Subarea VIII there is a longline fishery, which mainly targets greater forkbeard. There are also some trawl fisheries targeting species such as hake, megrim, anglerfish, and *Nephrops,* which have a by-catch of deepwater species. These include *Molva* spp., forkbeard (*Phycis phycis*), greater forkbeard, red seabream (*Pagellus bogaraveo*), conger eel (*Conger conger*), bluemouth, wreckfish (*Polyprion americanus*), and *Beryx* spp.

In ICES Subarea IX some deepwater species are a by-catch of the trawl fisheries for crustaceans. Typical species are bluemouth, greater forkbeard, conger eel, blackmouth dogfish (*Galeus melastomus*), kitefin shark (*Dalatias licha*), and gulper shark (*Centrophorus squamosus*). There is a directed longline fishery for black scabbardfish with a by-catch of the Portuguese dogfish (*Centroscymnus coelolepis)*. There is also a artisanal longline (Voracera) fishery for red seabream.

In ICES Subarea X the main fisheries are by handline and longline near the Azores and the main species landed are red seabream, wreckfish, conger eel, bluemouth, golden eye perch (*Beryx splendens*), and alfonsino (*Beryx decadactylus*). At present the catches of kitefin shark (*Dalatias licha*) are made by the longline and handline deepwater vessels and can be considered as accidental. There are no vessels at present catching this species using gillnets. Outside the Azorean EEZ there are trawl fisheries for golden eye perch, orange roughy, cardinal fish, black scabbard fish, and wreckfish. In 1998 and 1999 two commercial longliners from Madeira targeted black scabbardfish in this Subarea. In 1998 and 1999 some commercial fishing experiments targeting deepwater crustaceans species (deepwater crabs and shrimps), were also undertaken. There are trawl fisheries for golden eye perch, orange roughy, cardinal fish, black scabbardfish, and wreckfish.

In ICES Subarea XII there are trawl fisheries on the mid-Atlantic Ridge for orange roughy, roundnose grenadier, and black scabbard fish. There is a multi-species trawl and longline fisheries on Hatton Bank, in this Subarea and in Subarea VI. There is considerable exploratory fishing on this bank, and fishing effort seems to be increasing. Smoothheads were usually discarded but a substantial fraction of the catch is now landed.

In ICES Subarea XIV there are trawl and longline fisheries for Greenland halibut and redfish that have by-catches of roundnose grenadier, roughhead grenadier, and tusk.

4. Landings data

Landings for roughhead grenadier, sharks (various), silver scabbardfish (*Lepidopus caudatus*) smoothheads (*Alepocephalidae*), and wreckfish (*Polyprion americanus*) by ICES Subarea and country are given in Tables 3.13.1.1–5. For other species landings statistics and other information is given in subsequent sub-sections.

5. Assessment

Very few time-series based on the regular sampling of commercial landings exist. Basic statistics on catches and effort are of poor quality and in some cases lacking. As indicated previously for some major fisheries, it was not possible to update effort and CPUE, or directed effort for recent years were not available. There is often insufficient information on the general biology of these species, in particular on age and growth, seasonal behaviour, migration, and stock discrimination. New data on landings, discards, and biological parameters relevant to assessment have been collected as part of the EC FAIR Deep-fisheries Project (95/655). However, many of the discard sampling programs initiated under that project have been discontinued or continued only on an opportunistic basis. Although the necessary data are improving for certain stocks, the possibilities for traditional age-structured assessments only exist for a few stocks. Assessments using some alternative methodologies such as De Lury constant recruitment models and Schaefer production models continue to be used. CPUE analyses continue to be important for monitoring the status of stocks.

For many stocks, CPUE are the only supplementary data available, but in some fisheries where the exploitation has changed to different areas, such data are unreliable as indicators of stock abundance. There is a strong need for exploring all possible methods of monitoring the stocks. There is experience from outside the ICES region (e.g., acoustic and egg surveys), which should be considered.

Developments in acoustic survey techniques may lead to biomass estimates for some species. In the shorter term the use of trawl surveys may be the best method for monitoring some of these stocks.

There is substantial experience with developing deepwater fisheries outside the ICES region. ICES has also drawn on global experience in evaluating status and trends in deepsea species, and in formulating advice consistent with the precautionary approach.

6. Management considerations

Experience shows that deepsea stocks can be depleted very quickly and that recovery will be slow. These populations generally have a high proportion of old fish, their fecundities are low, and regeneration and growth are so slow that stock numbers do not increase in the depleted areas in the short or medium term.

The unusual body shape of many deepwater fish combined with a high age/length at maturity often means that there can be a high fishing mortality of immature fish. The survival rates of discards and of fish encountering gears and escaping are unknown, but many species are expected to be very vulnerable to injury, and therefore would be expected to die even if they escaped through meshes. Some species, such as blue ling, orange roughy, red sea bream, and alfonsino aggregate in shoals, often associated with seamounts, and can provide high catch rates once the shoals are located. Localized sub-units of the population can be quickly depleted by fisheries, even within a single season. Sub-units of some species (e.g., red sea bream, blue ling, and orange roughy) are known to have collapsed in some ICES areas.

It is evident that high catch rates can be maintained by moving from one concentration to another and progressively depleting the stock. Furthermore, many deepwater fisheries are on mixtures of species, making it difficult to manage the component species individually.

Fisheries for deepwater species are developing in areas inside and outside national jurisdictions. As a result exploitation is increasing on a number of species, as fishing extends into deeper waters or new areas, but the actual exploitation rates are often unknown. The quantities recorded are not always well estimated, and some landings are reported in grouped categories because of difficulties in separating species. In many cases significant proportions of the catch are discarded at sea and not recorded. All these factors make it difficult to determine which level of exploitation is sustainable.

The Code of Conduct for Responsible Fishing 7.5.4 (and the UN Agreement on Straddling Stocks, Article 6) states:

> *"In the case of new or exploratory fisheries, States should (shall) adopt as soon as possible cautious conservation and management measures, including, inter alia, catch limits and effort limits. Such measures should (shall) remain in force until there are sufficient data to allow assessment of the impact of the fisheries on the long-term sustainability of the stocks, whereupon conservation and management measures based on that assessment should (shall) be implemented. The latter measures should (shall), if appropriate, allow for the gradual development of the fisheries."*

Fisheries on deepwater species often develop and expand before sufficient information is available on which to base management advice. **Consistent with a precautionary approach, fishing should not be allowed to expand faster than the acquisition of information necessary to provide a basis for sustainable exploitation. There have been some improvements in recent years in data acquisition for some stocks while for others it has deteriorated. A comprehensive data collection system is urgently required, and research on all stocks should be increased to provide the data necessary for assessment**.

Continued fishing without biological data collection is not consistent with a precautionary approach. ICES recognised that NEAFC has established a reporting scheme providing catch statistics by detailed areas. **ICES recommends that where such schemes do not already exist, provision should be made for reporting landings to ICES at the species level for all species, including sharks. Provision should be retained, or made, for reporting at genus and higher grouped levels to allow for reports of landings which have not been sorted to the species level.** In this context the use of a hierarchical system of reporting should be encouraged.

ICES further recommends that improvements should be made in reporting landings from international waters by some states.

Management advice: **Most exploited deepwater species are at present considered to be harvested outside safe biological limits. ICES recommends immediate reduction in these fisheries unless they can be shown to be sustainable. New fisheries should be permitted only when they expand very slowly, and are accompanied by programs to collect data, which allow evaluation of stock status.**

Source of information: Report of the Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources, April 2002 (ICES CM 2002/ACFM:16).

Table 3.13.1.1 **Roughhead grenadier (*Macrourus berglax*).** Working Group estimates of landings (tonnes).

ROUGHHEAD GRENADIER (*Macrourus berglax*) I and II

Year	Germany	Norway	Russia	**TOTAL**
1988				
1989				
1990	9	580		**589**
1991		829		**829**
1992		424		**424**
1993		136		**136**
1994				
1995				
1996				
1997		17		**17**
1998		55		**55**
1999				
2000		35	13	**48**
2001		74	20	**94**

ROUGHHEAD GRENADIER (*Macrourus berglax*) III and IV

Year	France	Ireland	Norway	Scotland	**TOTAL**
1988					
1989					
1990					
1991					
1992			7		**7**
1993					
1994					
1995					
1996					
1997	36				**36**
1998					
1999					
2000		1	3+		**4**
2001	1	1	9		**11**

ROUGHHEAD GRENADIER (*Macrourus berglax*) Va

Year	Iceland	**TOTAL**
1988		
1989		
1990		
1991		
1992		
1993		
1994		
1995		
1996	15	**15**
1997	4	**4**
1998	1	**1**
1999		
2000	5	**5**
2001		

Table 3.13.1.1 (Cont'd)

ROUGHHEAD GRENADIER (*Macrourus berglax*) Vb

Year	France	Norway	TOTAL
1988			
1989			
1990			
1991			
1992			
1993			
1994			
1995			
1996			
1997			
1998	9		**9**
1999	58		**58**
2000	1		**1**
2001	2	2	**4**

ROUGHHEAD GRENADIER (*Macrourus berglax*) VI and VII

Year	EWN	France	Norway	Scotland	TOTAL
1988					
1989					
1990					
1991					
1992					
1993	18				**18**
1994	5				**5**
1995	2				**2**
1996					
1997					
1998					
1999		34			**34**
2000	+	1		8	**9**
2001		1	27		**28**

ROUGHHEAD GRENADIER (*Macrourus berglax*) X

Country	France	TOTAL
1988		
1989		
1990		
1991		
1992		
1993		
1994		
1995		
1996		
1997		
1998		
1999	3	**3**
2000		
2001		

Table 3.13.1.1 (Cont'd)

ROUGHHEAD GRENADIER *(Macrourus berglax)* XII

Country	Norway	TOTAL
1988		
1989		
1990		
1991		
1992		
1993		
1994		
1995		
1996		
1997		
1998		
1999		
2000	7	**7**
2001	9	**9**

ROUGHHEAD GRENADIER *(Macrourus berglax)* XIV

Country	Greenland	Norway	TOTAL
1988			
1989			
1990			
1991			
1992			
1993	18	34	**52**
1994	5		**5**
1995	2		**2**
1996			
1997			
1998		6	**6**
1999		14	**14**
2000			
2001		26	**26**

ROUGHHEAD GRENADIER *(Macrourus berglax)*. All areas.

Year	I and II	III and IV	Va	Vb	VI and VII	X	XII	XIV	TOTAL
1988									
1989									
1990	589								**589**
1991	829								**829**
1992	424	7							**431**
1993	136				18			52	**206**
1994					5			5	**10**
1995					2			2	**4**
1996			15						**15**
1997	17	36	4						**57**
1998	55			9				6	**70**
1999				58	34	3		14	**109**
2000	48	4	4	1	9		7		**73**
2001	94	11		4	28		9	26	**172**

Table 3.13.1.2 **Sharks.** Working Group estimates of landings (tonnes).

Working Group estimates of landings of deepwater sharks, and of sharks not elsewhere identified (various) that are known to contain some landings of deepwater species. Landings data indicated as "deep" for France, Ireland, and the UK are almost exclusively *C. coelolepis* and *C. squamosus*. In the case of other countries they may contain some other species. Data for 2001 are preliminary. "Aiguillat noir" is a new category of small squalids and is considered separately from the main commercially important squalid sharks in the summary landings tables.

Shark landings in Division IVa

Year	France		Denmark	UK (E & W)	UK (Scot.)
	deep	aiguillat. noir	*E. spinax*	various	various
1991	3				
1992	133				
1993	51		27		
1994	86		0		
1995	10		10		
1996	6		8		
1997			32		
1998			359		
1999	20		128		53
2000	0	1	25	2	8
2001	0		52	0	10

Shark landings in Division Va

	Iceland		Germany
	S. microcephalus	*C. coelolepis*	various
1988			
1989	31		
1990	54		3
1991	58		133
1992	70		51
1993	39		86
1994	42		10
1995	45		6
1996	65		
1997	70		
1998	82	5	20
1999	45		0
2000	45		0
2001	56		

Table 3.13.1.2 (Cont'd)

Shark landings in Division Vb

	France	Norway	Germany	UK (E & W)		Scotland		Faroe Islands	
	deep	deep	various	deep	various	deep	various	various	*C. coelolepis*
1990	140								
1991	75							3	
1992	123				5			36	
1993	91		2		9			376	
1994	149		43						
1995	262								
1996	348		31		1				
1997	261		27		20				
1998	354								79
1999	461		1				8		
2000	306	0	0		54	11	15	2*	23
2001	297	25	0	4	93	5	119	576**	

* *Centrophorus squamosus*
** *Centrophorus squamosus* and *Centroscymnus coelolepis*.

Shark landings in Division VIa

	France		Ireland	Norway	Germany	UK (E & W)		UK (Scot.)	
	deep	a. noir	deep	deep	various	deep	various	deep	various
1999	1651								136
2000	2124	127	21	0	1	244	119	181	25
2001	2332	120	21	149	8	98	24	386	36

Shark landings in Division VIb

	France		Ireland	Norway	Germany	UK (E & W)		UK (Scot)	
	Siki	*C. fabricii*	deep	deep	various	deep	various	deep	various
1999	472								112
2000	346	1		41	177	26	220	24	23
2001	247	4	5	83	34	219	168	127	8

Shark landings in Division VIb taken by Spain on Hatton Bank

	C. squamosus	*C. coelolepis*	*D. calceus*	*C. repidater*	*C. fabricii*	*Etmopterus sp.*
2000	0	33	0	0	1	0
2001	0	120	0	0	0	21

Table 3.13.1.2 (Cont'd)

Shark landings reported in Subareas VI and VII

	France	Spain	Germany	UK (E & W)	UK (Scot.)	Faeroe Islands
	deep (VI only)	various	various	various	various	various
1988		66		19		
1989				32	8	
1990				38	5	
1991	944			201	53	
1992	1953			503	133	3
1993	2454		124	821	447	
1994	2198		395	742	727	
1995	1784		2	1315	782	
1996	2374		276	1345	555	
1997	2222	152	66	2721	301	
1998	2081	645	65	1812	501	
1999		199	189	1403		
2000		8				
2001		0				

Shark landings in Subarea VII

	France	France	Ireland	Germany	UK (E & W)		UK (Scot.)	
	deep	*C. fabricii*	deep	various	deep	various	deep	various
1991	265							
1992	878							
1993	857							
1994	1363							
1995	991							
1996	754							
1997	571							
1998	673							
1999	440							244
2000	506	4	92	85	23	76	0	3
2001	417	6	159	164	353	130	103	21

Deepwater shark landings taken by Portugal in Division IXa

Year	*C. granulosus*	*C. squamosus*	*C. coelolepis*	*D. licha*	*G. melastomus*
1988	995	560	na	149	21
1989	1027	507	na	57	17
1990	1056	475	na	7	17
1991	801	424	651	12	17
1992	958	422	692	11	16
1993	886	339	607	11	20
1994	344	579	576	11	37
1995	423	544	810	7	29
1996	242	412	777	4	35
1997	291	384	927	4	29
1998	187	362	858	6	22
1999	92	428	544	6	23
2000	54	438	611		
2001	93	510	620	7	35

Table 3.13.1.2 (Cont'd)

Shark landings in Subareas VIII and IX

Year	Spain various	France deep (VIII only)	UK (E& W) various	UK (Scot.) various
1988	3545			
1989	1789			
1990	na			
1991	2850			
1992	3740	15	0	0
1993		9		0
1994		8		4
1995		0	32	7
1996		1	25	0
1997	1059	1	20	
1998	1811	13		
1999	476	20		
2000	228	21		
2001	321	5		

Deepwater shark landings taken by Portugal (Azores) in Subarea X

	C. squamosus	*D. licha*
1988		549
1989		560
1990		602
1991		896
1992		761
1993		591
1994		309
1995		321
1996		216
1997		30
1998	4	34
1999	8	31
2000		31
2001		13

Shark landings in Subarea XII

	France	France	Ireland	Norway	UK (E & W)	UK (Scot)	
	deep	***C. fabricii***	deep	deep	various	deep	various
1991	1						
1992	2						
1993	6						
1994	8						
1995	139						
1996	147						
1997	32						
1998	56						
1999	50						
2000	190	3		77	35	3	3
2001	23	2	29	142		36	

Table 3.13.1.2 (Cont'd)

Shark landings in Subarea XII caught by Spain on Hatton Bank

	C. squamosus	*C. coelolepis*	*D. calceus*	*C. repidater*	*C. fabricii*	*Etmopterus* sp.
2000	34	505	12	85	84	38
2001	2	493	5	68	91	317

Summary of available landings data for large deepwater squalid sharks by Subarea. No data were available for VIII from most countries.

Year	IVa	Va	Vb	VI	VII	VIII	IX a Portugal	X Azores	XII	Total
1988							1704	549		**2253**
1989							1591	560		**2151**
1990			140				3129	602		**3871**
1991	3		75	944	265		3426	896	1	**5610**
1992	133		123	1953	878	15	3971	761	2	**7836**
1993	51		91	2454	857	9	3926	591	6	**7985**
1994	86		149	2198	1363	8	3353	309	8	**7474**
1995	10		262	1784	991	0	3294	321	139	**6801**
1996	6		348	2374	754	1	3219	216	147	**7065**
1997			261	2222	571	1	3041	30	32	**6158**
1998		5	433	2081	673	13	3019	38	56	**6318**
1999	20		461	2123	440	20	2483	39	50	**5636**
2000	1		342	3010	621	21	2173	31	951	**7150**
2001*	0		907	3679	1032	5	2333	13	1206	**9175**

*preliminary data

Total shark (various, including some deepwater sharks) landings by Subareas.

Year	IVa	Va	Vb	VI	VII	VI+VII*	VIII+IX	XII	***Total***
1988						85	3545		**3630**
1989		31				40	1789		**1860**
1990		54	140			43	1789		**2026**
1991	3	58	78	944	265	254	2850	1	**4453**
1992	133	70	164	1953	878	639	6590	2	**10429**
1993	78	39	478	2454	857	1392	3740	6	**9044**
1994	86	42	192	2198	1363	1864	4	8	**5757**
1995	20	45	262	1784	991	2099	43	139	**5383**
1996	14	65	380	2374	754	2176	64	147	**5974**
1997	32	70	308	2222	571	3240	1104	32	**7579**
1998	359	87	433	2081	673	3023	2890	56	**9602**
1999	201	45	470	2371	440	1791	2287	50	**7655**
2000	36	45	409	3704	789	8	704	1069	**6764**
2001*	62	57	543	4102	1353	0	549	1208	**7874**

* Preliminary.

Some countries reported data for VI and VII combined, while others reported data separately for each Subarea. The column for VI and VII combined shows data reported for both Subareas combined, but does not contain landings for VI and VII reported separately.

Table 3.13.1.3 **Silver Scabbardfish (*Lepidopus caudatus*)**. Working Group estimates of landings (tonnes).

SILVER SCABBARDFISH (*Lepidopus caudatus*). VI and VII

Year	EWN	France	Germany	Scotland	**TOTAL**
1988					
1989					
1990					
1991					
1992					
1993			2		**2**
1994					
1995					
1996					
1997					
1998					
1999		18			**18**
2000	+		3	12	**15**
2001					

SILVER SCABBARDFISH *(Lepidopus caudatus).* VIII and IX

Year	France	Portugal	Spain	Russia/USSR	**TOTAL**
1988		2666			**2666**
1989		1385			**1385**
1990		547		37	**584**
1991		808			**808**
1992		1264		110	**1374**
1993		2397			**2397**
1994		1054			**1054**
1995		5672			**5672**
1996		1237			**1237**
1997		1725			**1725**
1998		966			**966**
1999	2	3067	1584		**4653**
2000	1	15	14		**30**
2001	2	22			**24**

SILVER SCABBARDFISH (*Lepidopus caudatus*). X

Year	Latvia	Portugal	**TOTAL**
1988		70	**70**
1989		91	**91**
1990		120	**120**
1991		166	**166**
1992	1905	255	**2160**
1993	1458	264	**1722**
1994		373	**373**
1995	8	781	**789**
1996		815	**815**
1997		1115	**1115**
1998		1186	**1186**
1999		86	**86**
2000		28	**28**
2001		14	**14**

Table 3.13.1.3 (Cont'd)

SILVER SCABBARDFISH (*Lepidopus caudatus*). XII

Country	Russia/USSR	**TOTAL**
1988		
1989	102	**102**
1990	20	**20**
1991		
1992		
1993	19	**19**
1994		
1995		
1996		
1997*		
1998		
1999		
2000		
2001		

SILVER SCABBARDFISH (*Lepidopus caudatus*). All areas

	VI and VII	VIII and IX	X	XII	**TOTAL**
1988		2666	70		**2736**
1989		1385	91	102	**1578**
1990		584	120	20	**724**
1991		808	166		**974**
1992		1374	2160		**3534**
1993	2	2397	1722	19	**4140**
1994		1054	373		**1427**
1995		5672	789		**6461**
1996		1237	815		**2052**
1997		1725	1115		**2840**
1998		966	1186		**2152**
1999	18	4653	86		**4757**
2000	15	30	28		**73**
2001		24	14		**38**

Table 3.13.1.4 **Smoothheads (Alepocephalidae).** Working Group estimates of landings (tonnes).

SMOOTHHEAD *(Alepocephalus* spp.) Va

Year	Iceland	**TOTAL**
1988		
1989		
1990		
1991		
1992	10	**10**
1993	3	**3**
1994	1	**1**
1995	1	**1**
1996		
1997	+	
1998		
1999		
2000		
2001		

SMOOTHHEAD (*Alepocephalus* spp.) XII

Year	Spain	**TOTAL**
1988		
1989		
1990		
1991		
1992		
1993		
1994		
1995		
1996	230	**230**
1997	3692	**3692**
1999	4643	**4643**
1999	6549	**6549**
2000	978	**978**
2001	3902	**3902**

SMOOTHHEAD (*Alepocephalus* spp.) XIV

Year	Germany	Spain	**TOTAL**
1988			
1989			
1990			
1991			
1992			
1993			
1994			
1995			
1996			
1997			
1999			
1999			
2000	12	4146	**4158**
2001		4121	**4121**

Table 3.13.1.4 (Cont'd)

SMOOTHHEAD (*Alepocephalus* spp.). All areas

Year	Va	XII	XIV	**TOTAL**
1988				
1989				
1990				
1991				
1992	10			**10**
1993	3			**3**
1994	1			**1**
1995	1			**1**
1996		230		**230**
1997		3692		**3692**
1999		4643		**4643**
1999		6549		**6549**
2000		978	4158	**5136**
2001		3902	4121	**8023**

Table 3.13.1.5 Wreckfish (*Polyprion americanus*). Working Group estimates of landings (tonnes).

WRECKFISH (*Polyprion americanus*). VI and VII

Year	France	Ireland	Spain	**TOTAL**
1988	7			**7**
1989				
1990	2			**2**
1991	10			**10**
1992	15			**15**
1993	0			
1994				
1995				
1996	4		79	**83**
1997				
1998			12	**12**
1999	9		5	**14**
2000	13		1	**14**
2001	15	1	1	**17**

WRECKFISH (*Polyprion americanus*). VIII and IX

Year	France	Portugal	Spain	UK (EW)	**TOTAL**
1988	1	188	9		**198**
1989	1	283			**284**
1990	2	161			**163**
1991	3	191			**194**
1992	1	268			**269**
1993		338			**338**
1994		406	3		**409**
1995		372	19	2	**393**
1996	3	214	69	8	**294**
1997		170	44		**214**
1998		164	63		**227**
1999	7	137	7		**151**
2000	12	72	37		**121**
2001	3	77	85		**165**

WRECKFISH (*Polyprion americanus*) X

Year	France	Portugal	Norway	**TOTAL**
1988		191		**191**
1989		235		**235**
1990		224		**224**
1991		170		**170**
1992	3	234		**237**
1993		308	3	**311**
1994		428		**428**
1995		240		**240**
1996		240		**240**
1997		177		**177**
1998		139		**139**
1999		133		**133**
2000		268		**268**
2001		232		**232**

Table 3.13.1.5 (Cont'd)

WRECKFISH (*Polyprion americanus*). All areas

	VI and VII	VIII and IX	X	**TOTAL**
1988	7	198	191	**396**
1989		284	235	**519**
1990	2	163	224	**389**
1991	10	194	170	**374**
1992	15	269	237	**521**
1993		338	311	**649**
1994	0	409	428	**837**
1995	0	393	240	**633**
1996	83	294	240	**617**
1997	0	214	177	**391**
1998	12	227	139	**378**
1999	14	151	133	**298**
2000	14	121	268	**403**
2001	17	165	232	**414**

3.13.2 Blue Ling (*Molva dypterygia*)

State of the stock/exploitation: The stock of blue ling in the North Atlantic is outside safe biological limits. Although the stock structure is uncertain, catches and CPUE series (Figures 3.13.2.1 and 3.13.2.2) show declining trends in Divisions Va and Vb and in Subareas VI and VII, where more than 85% of catches of blue ling have been taken over the past five years. Using trawl and survey CPUE as indices, the exploitable biomass at the end of 2001 is considered to be below 20% of the maximum observed biomass. The proportion of large fish in the landings from Divisions Va, Vb and Subareas VI and VII has decreased in the most recent years.

The state of the stock in other areas is not known; however, it is believed that the stock development is similar, as represented by the CPUE index. The increase in total catches in 1995–2001 is almost exclusively accounted for by Subarea VI and XII, where effort has increased.

Advice on management: ICES recommends that there be no directed fisheries for this stock and that technical measures such as closed areas on spawning aggregations be implemented to minimise catches of this stock in mixed fisheries.

Relevant factors to be considered in management: A major part of this fishery is on spawning aggregations. Experience in Divisions Va and Vb indicates that once stocks are fished down they do not recover, even when fishing pressure has been low for up to about seven years. Age estimation is still a problem in this species.

Comparison with previous assessment and advice: There is no change in the perception of the stock compared to previous assessment.

Elaboration and special comments: The indicators of the stock status come from Division Va, Vb and Subareas VI and VII. Together these have contributed at least 85% of the catch in recent years.

The French commercial trawl CPUE time-series in Subareas VI, VII, and Division Vb, which is based on a reference fleet of strictly deepwater trawlers, was updated. Icelandic CPUE series from commercial trawlers and longliners from Area Va were provided, as well as indices on blue ling from the Icelandic groundfish survey. Spanish CPUE series for trawl and longliners in Subareas VI and VII were provided. The Faroese commercial trawl CPUE series in Division Vb was not updated. Attempts to use a modified DeLury constant recruitment model and a Schaeffer production model on the CPUE data were unsuccessful. All the available evidence from trends in catches and CPUE series indicate that blue ling abundance in these areas is at a low level.

Little is known of the early life history of this species.

Landings from Division IIa are mainly taken in a gillnet fishery off mid-Norway. The relatively minor landings from Subarea III and Division IVa are by-catches in trawl fisheries. In Division Va blue ling have mainly been taken by trawlers in the redfish and Greenland halibut fisheries in recent years. In this division a directed fishery on spawning concentrations was carried out from 1980 to 1984 in a very limited area. Between 1993 and 1996 a fishery on spawning concentrations was conducted on the Reykjanes Ridge at the border between Division Va and Subarea XIV. The fishery in Division Vb is mainly a bottom trawl fishery on spawning aggregations. The trawl fishery is also predominant in Subarea VI.

Landings by ICES Subareas and Division by country are given in Table 3.13.2.1.

Source of information: Report of the Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources, 4–10 April 2002 (ICES CM 2002/ACFM:16).

Catch data (Table 3.13.2.1):

Year	ACFM Catch
1988	25
1989	20
1990	16
1991	16
1992	17
1993	19
1994	10
1995	11
1996	11
1997	13
1998	13
1999	16
2000	14
2001*	16

*Preliminary. Weights in ‘000 t.

Blue ling (*Molva dypterygia*)

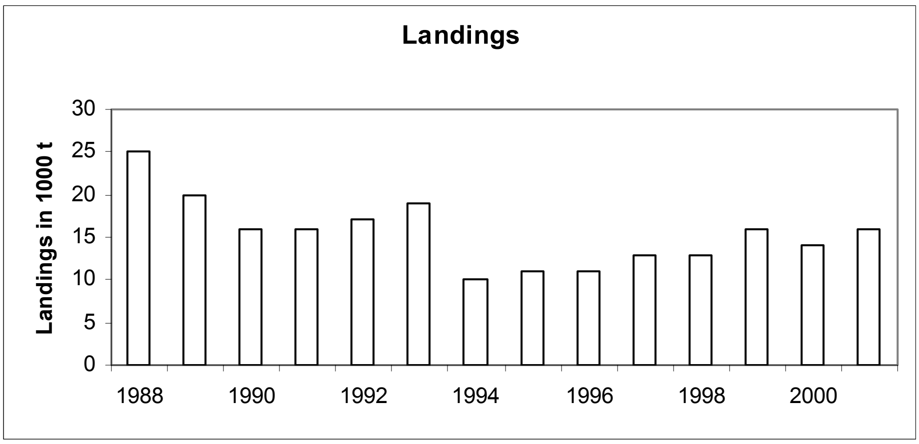


Table 3.13.2.1 Blue ling (*Molva dypterygia*). Working Group estimates of landings (tonnes).

Blue ling in Subarea I

Year	Iceland	Norway	Germany	Total
1988	-	-	-	-
1989	-	-	-	-
1990	-	-	-	-
1991	-	-	-	-
1992	-	-	-	-
1993	-	-	-	-
1994	-	3	-	3
1995	+	5	-	5
1996	-	+	-	+
1997	+	1	-	1
1998	-	1	-	1
1999	-	1	-	1
2000	-	3	+	3
2001*	-	1	-	1

*Preliminary.

Blue ling in Divisions IIa and b

Year	Faroes	France	Germany	Greenland	Norway	E & W	Scotland	Total
1988	77	37	5	-	3,416	2	-	3,537
1989	126	42	5	-	1,883	2	-	2,058
1990	228	48	4	-	1,128	4	-	1,412
1991	47	23	1	-	1,408	-	-	1,479
1992	28	19	+	3	987	2	-	1,039
1993	-	12	2	3	1,003	+	+	1,020
1994	-	9	2	-	399	9	-	419
1995	0	12	2	2	342	1	-	359
1996	0	8	1	-	254	2	2	267
1997	0	10	1	-	280	+	-	291
1998	0	3	+	-	272	+	3	278
1999	0	1	1	-	287	+	2	291
2000	-	2	4	-	240	1	2	249
2001*	-	6	+	-	190	1	2	199

*Preliminary.

Blue ling in Subarea III

Year	Denmark	Norway	Sweden	Total
1988	10	11	1	22
1989	7	15	1	23
1990	8	12	1	21
1991	9	9	3	21
1992	29	8	1	38
1993	16	6	1	23
1994	14	4	+	18
1995	16	4		20
1996	9	3		12
1997	14	5	2	21
1998	4	2		6
1999	5	1		6
2000	13	1		14
2001*	20	4		24

*Preliminary. Continued …

Table 3.13.2.1 Continued

Blue ling in Division IVa

Year	Denmark	Faroes	France [1]	Germany	Norway	E & W	Scotland	Ireland	Total
1988	1	13	223	6	116	2	2	-	363
1989	1	-	244	4	196	12	+	-	457
1990	+	-	321	8	162	4	+	-	495
1991	1	31	369	7	178	2	32	-	620
1992	1	-	236	9	263	8	36	-	553
1993	2	101	76	2	186	1	44	-	412
1994	+		144	3	241	14	19	-	421
1995	+	2	73	+	201	8	193	-	477
1996	+	0	52	4	67	4	52	-	179
1997	+	0	36	+	61	0	172	-	269
1998	+	1	31	-	55	2	191	-	280
1999	2		21	+	94	25	120	2	264
2000	2		15	1	53	10	46	2	129
2001*	7		9	+	75	7	145	9	252

*Preliminary. [1] Included in VI.

Blue ling in Division IVb

Year	France	E & W	Norway	Faroes	Denmark	Germany	Scotland	Total
1988	-	-	-	-	-	-	-	-
1989	2	-	-	-	-	-	-	2
1990	6	-	-	-	-	-	-	6
1991	7	-	-	-	-	-	-	7
1992	1	-	-	-	-	-	-	1
1993	0	3	-	-	-	-	-	3
1994	0	-	+	+	-	-	-	0
1995	3	3	+	-	+	-	-	6
1996	5	5	1	-	+	-	-	11
1997	1	-	+	-	-	-	-	1
1998	5	-	1	-	-	-	-	6
1999	(1)	1	0	-	-	+	+	1
2000	1	-	-	-	-	+	-	1
2001*	0	-	-	-	+	+	+	0

*Preliminary.

Blue ling in Division IVc

Year	E & W	Norway	Total
1988	-	-	-
1989	-	-	-
1990	-	-	-
1991	-	-	-
1992	-	-	-
1993	-	-	-
1994	3	-	3
1995	-	-	-
1996	-	-	-
1997	-	-	-
1998	-	-	-
1999	-	0	-
2000	-	-	-
2001*	-	-	-

*Preliminary.

Continued …

Table 3.13.2.1 Continued

Blue ling in Division Va

Year	Faroes	Germany	Iceland	Norway	E & W	Scotland	Total
1988	271	-	1,893	7	-	-	2,171
1989	403	-	2,125	5	-	-	2,533
1990	1,029	-	1,992	-	-	-	3,021
1991	241	-	1,582	1	-	-	1,824
1992	321	-	2,584	1	-	-	2,906
1993	40	-	2,193	-	-	-	2,233
1994	89	1	1,542	-	-	-	1,632
1995	113	3	1,519	-	-	-	1,635
1996	36	3	1,284	-	-	-	1,323
1997	25	+	1,319	-	-	-	1,344
1998	59	9	1,086	-	-	-	1,154
1999	31	8	1,525	8	8	3	1,583
2000	36	7	1,605	25	7	+	1,680
2001*	69	12	753	49	1	1	885

*Preliminary.

Blue ling in Sub-division Vb_1

Year	Faroes	France [3]	Germany [2]	Norway	E & W	Scotland [1]	Ireland	Russia	Total
1988	3,487	3,036	49	94	-	…	-	-	6,666
1989	2,468	1,800	51	228	-	…	-	-	4,547
1990	946	3,073	71	450	-	…	-	-	4,540
1991	1,573	1,013	36	196	1	…	-	-	2,819
1992	1,918	407	21	390	4	…	-	-	2,740
1993	2,088	192	24	218	19	…	-	-	2,541
1994	1065	147	3	173	-	…	-	-	1,388
1995	1,606	588	2	38	4	…	-	-	2,238
1996	1,100	301	3	82	+	…	-	-	1,486
1997	778	1,656	+	65	11	…	-	-	2,510
1998	1,026	1,411	0	24	1	…	-	-	2,462
1999	1,730	1,068	4	38	4	…	-	-	2,844
2000	1,561	575	1	163	33	…	-	1	2,334
2001*	1,547	344	4	130	8	…	2	-	2,035

*Preliminary. [1] Included in Vb_2. [2] Includes Vb_2. [3] Reported as Vb.

Blue ling in Sub-division Vb_2

Year	Faroes	Norway	Scotland [1]	E & W	Total
1988	2,788	72	-	-	2,860
1989	622	95	-	-	717
1990	68	191	-	-	259
1991	71	51	21	-	143
1992	1,705	256	1	-	1,962
1993	182	22	91	-	295
1994	239	16	1	-	256
1995	162	36	4	-	202
1996	42	62	12	-	116
1997	229	48	11	-	288
1998	64	29	29	-	122
1999	15	49	24	-	88
2000	107	37	37	-	181
2001*	147	69	63	1	280

*Preliminary. [1] Includes Vb_1.

Continued …

Table 3.13.2.1 Continued

Blue ling in Division VIa

Year	Faroes	France	Germany	Ireland	Norway	Spain [1]	E & W	Scotland	Total
1988	14	6,614	2	-	29	-	2	1	6,662
1989	6	7,382	2	-	143	-	-	+	7,533
1990	-	4,882	44	-	54	-	-	1	4,981
1991	8	4,261	18	-	63	-	1	35	4,386
1992	4	5,483	4	-	129	-	-	24	5,644
1993	-	4,311	48	3	27	-	13	42	4,444
1994	-	2,999	24	73	90	433	1	91	3,711
1995	0	2,835	+	11	96	392	34	738	4,106
1996	0	4,115	4	-	50	681	9	1,407	6,266
1997	0	3,845	+	1	29	190	789	1,021	5,875
1998	0	4,644	3	1	21	142	11	1,416	6,238
1999	0	3,730	+	10	55	119	5	1,105	5,024
2000	-	4,441	94	9	102	57	24	1,300	6,027
2001*	-	2,550	6	52	117	1,009	116	2,136	5,986

*Preliminary. [1] Includes VIb.

Blue ling in Division VIb

Year	Faroes	France	Germany	Norway	E & W	Scotland	Iceland	Ireland	Estonia	Total
1988	2,000	499	37	42	9	14	-	-	-	2,601
1989	1,292	61	22	217	-	16	-	-	-	1,608
1990	360	703	-	127	-	2	-	-	-	1,192
1991	111	2,482	6	102	5	15	-	-	-	2,721
1992	231	348	2	50	2	14	-	-	-	647
1993	51	373	109	50	66	57	-	-	-	706
1994	5	89[1]	104	33	3	25	-	-	-	259
1995	1	305	189	12	11	38	-	-	-	556
1996	0	87[1]	92	7	37	74	-	-	-	297
1997	138	331	-	6	65	562	1	-	-	1,103
1998	76	469	-	13	190	287	122	11	-	1,168
1999	204	690	-[2]	9	168	2,411	610	4	-	4,096
2000	+	508	-	184	500	966	-	7	-	2,165
2001*	-	202	1	256	1,499	1,803	-	4	85	3,850

*Preliminary. [1] Includes XII. [2] Included in VIa.

Blue ling in Division VIIa

Year	France [1]	Scotland	**Total**
1988	…	-	-
1989	…	-	-
1990	…	-	-
1991	…	1	1
1992	…	-	-
1993	…	-	-
1994	…	-	-
1995	…	-	-
1996	…	-	-
1997	…	-	-
1998	…	-	-
1999	…	-	-
2000	…	-	-
2001*	…	-	-

*Preliminary. [1] Included in VIa.

Continued …

Table 3.13.2.1 Continued

Blue ling in Divisions VIIb,c

Year	France	Germany	Ireland	Norway	Spain [1]	E & W	Scotland	Total
1988	21	1	-	-	…	-	-	22
1989	269	-	-	2	…	-	-	271
1990	177	-	-	-	…	-	-	177
1991	157	-	-	-	…	-	-	157
1992	126	-	-	3	…	-	6	135
1993	106	-	-	2	…	11	28	147
1994	100	-	1	1	…	6	22	130
1995	95	-	3	-	…	3	11	112
1996	118	-	-	1	…	15	57	191
1997	113	-	0	2	…	36	3	154
1998	157	-	-	1	…	60	6	224
1999	36	-	3	1	…	24	7	71
2000	45	1	45	5	…	9	2	107
2001*	31	+	169	5	…	16	3	224

*Preliminary. [1] Included in VIIg-k.

Blue ling in Divisions VIId,e

Year	France	Total
1988	0	0
1989	1	1
1990	0	0
1991	10	10
1992	15	15
1993	3	3
1994	8	8
1995	4	4
1996	4	4
1997	1	1
1998	3	3
1999	-	-
2000	-	-
2001*	-	-

*Preliminary.

Blue ling in Divisions VIIg-k

Year	France [1]	Germany	Spain [1]	E & W	Scotland	Ireland	Total
1988	-	-	-	-	-	-	-
1989	21	-	-	-	-	-	21
1990	46	-	-	-	-	-	46
1991	44	-	-	-	-	-	44
1992	256	-	-	-	-	-	256
1993	164	-	-	5	2	-	171
1994	190	-	4	3	4	-	201
1995	56	-	13	40	5	-	114
1996	67	-	21	42	40	-	170
1997	65	8	0 [2]	134	12	9	228
1998	92	-	22 [2]	223	24	10	371
1999	40	2[2]	59 [2]	144	11	24	280
2000	39	1	63 [2]	22	15	30	170
2001*	41	2	59 [2]	14	14	325	455

*Preliminary. [1] Included in VIIb,c. [2] Reported as VII. Continued …

Table 3.13.2.1 Continued

Blue ling in Subarea XII

Year	Faroes	France	Germany	Spain	E & W	Scotland	Norway	Iceland	Total
1988	-	263	-	-	-	-	-	-	263
1989	-	70	-	-	-	-	-	-	70
1990	-	5	-	-	-	-	-	-	5
1991	-	1,147	-	-	-	-	-	-	1,147
1992	-	971	-	-	-	-	-	-	971
1993	654	2,591	90	-	-	-	-	-	3,335
1994	382	345(1)	25	-	-	-	-	-	752
1995	514	47	-	-	12	-	-	-	573
1996	445	60(1)	-	264	-	19	-	-	788
1997	1	1	-	411	4	-	-	-	417
1998	36	26	-	375	1	-	-	-	438
1999	156	17	-	943	8	43	-	186	1,353
2000	-	23	-	406	18	23	21	14	505
2001*	-	26	-	585	32	91	103	2	839

*Preliminary. (1) Included in VIa.

Blue ling in Subarea XIV

Year	Faroes	France	Germany	Greenland	Iceland	Norway	E & W	Scotland	Spain	Total
1988	21	-	218	3	-	-	-	-	-	242
1989	13	-	58	-	-	-	-	-	-	71
1990	-	-	64	5	-	-	10	-	-	79
1991	-	-	105	5	-	+	45	-	-	155
1992	-	-	27	2	-	50	27	4	-	110
1993	-	390	16	-	3,124	173	21	1	-	3,725
1994	1	-	15	-	300	11	57	-	-	384
1995	0	-	5	-	117	+	16	3	-	141
1996	0	(1)	12	-	-	+	2	+	-	14
1997	1	-	1	-	-	+	2	-	-	4
1998	48	-	-	-	-	1	6	-	-	55
1999	-	-	+	-	-	1	7	-	-	8
2000	+	-	-	-	4	-	2	-	526	532
2001*	-	-	-	-	-	-	6	-	1,175	1,181

*Preliminary.

BLUE LING - Total landings by area/division and grand total

Year	I	II	III	III	IV	Va	Vb	VI	VII	XII	XIV	Total
1988	0	3,537	218	22	363	2,171	9,526	9,263	22	263	242	25,409
1989	0	2,058	58	23	459	2,533	5,264	9,141	293	70	71	19,912
1990	0	1,412	64	21	501	3,021	4,799	6,173	223	5	79	16,234
1991	0	1,479	105	21	627	1,824	2,962	7,107	212	1,147	155	15,534
1992	0	1,039	27	38	554	2,906	4,702	6,291	406	971	110	17,017
1993	0	1,020	16	23	415	2,233	2,836	5,150	321	3,335	3,725	19,058
1994	3	419	15	18	424	1,632	1,644	3,970	339	752	384	9,585
1995	5	359	5	20	483	1,635	2,440	4,662	230	573	141	10,548
1996	0	267	12	12	190	1,323	1,602	6,563	365	788	14	11,124
1997	1	291	1	21	270	1,344	2,798	6,978	383	417	4	12,507
1998	1	278	-	6	286	1,154	2,584	7,406	598	438	55	12,806
1999	1	291	+	6	265	1,583	2,932	9,120	351	1,353	8	15,910
2000	3	249	-	14	130	1,680	2,515	8,192	277	505	532	14,097
2001*	1	199	-	24	252	816	2,311	9,836	679	839	1,181	16,211

*Preliminary.

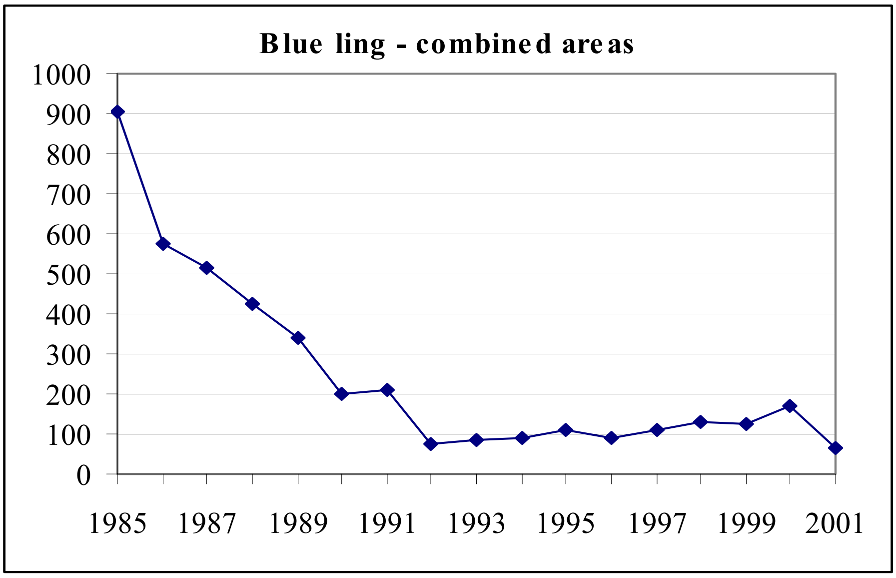


Figure 3.13.2.1 Blue ling in Division Vb and Subareas VI-VII combined. CPUE from total catch and effort 1985–2001 of French trawlers.

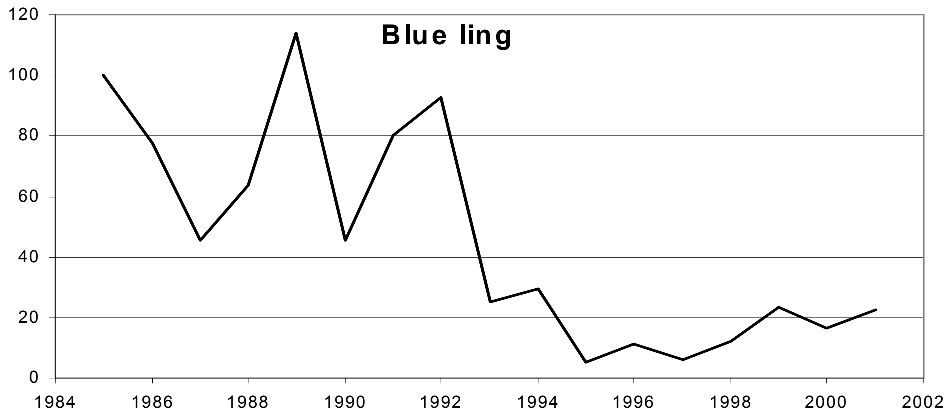


Figure 3.13.2.2 Blue ling. Index on fishable biomass calculated from the Icelandic groundfish survey on the Icelandic shelf.

3.13.3 Ling (*Molva molva*)

State of the stock/exploitation: The state of the stock is highly uncertain due to the lack of updated information. In previous years it was considered to be outside safe biological limits in at least some parts of its range, and there are no reasons to believe that the situation has changed. The CPUE series for many important fishing areas have not been updated, and the abundance trends are unclear. Previously presented estimates of Z for the last decade are about 0.7 to 0.8 for several areas. The only new information is the updated series from the groundfish survey in Division Va that suggests a decline also in this area.

Advice on management: ICES recommends that the overall fishing effort be reduced by 30%.

Relevant factors to be considered in management: The reduction in effort is expected to reduce total mortality to values, which are considered sustainable for species with similar life histories.

Comparison with previous assessment and advice: No comparison of assessments was possible. In Division Va, the survey index from the Icelandic groundfish survey suggests declining abundance.

Elaboration and special comment: For fleets which target ling the advised effort reduction can be applied directly. For fleets which take ling as by-catch the advised effort reduction will help to achieve the reductions in catch and effort that ICES has advised for many years for the species they target.

The major fishery in Division IIa is the Norwegian longline fishery. This fishery also operates in other Subareas and Divisions, such as IVa, V, and VI. The catches in Division Va are by-catches in longline, gillnet, and bottom trawl fisheries. In Division Vb the majority of the catch is taken by longliners rather than trawlers. In Subareas VI and VII trawl fisheries are predominant.

With the exception of data from the Spanish trawlers in Subareas VI and VII, none of the other CPUE series have been updated since 2000 or even earlier. New series were presented for French and Danish fisheries, but these represent relatively minor by-catches and are of limited value for assessments. Future advice on stock status would benefit significantly by updating the CPUE data series from the major fisheries. No new mortality estimates were available after 1999. An improvement in the reporting of catch and effort and biological information should be encouraged for all fisheries.

There is currently no evidence of separate stocks within the ICES area; however, the distribution is unlikely to be homogeneous across its entire range and deep channels may present barriers to movement. These factors, combined with different histories of fishing activity in the different Subareas, mean that the status of the stock is likely to be variable across its range. Localised population units may respond differently to management measures applied on various geographic scales.

Ling (*Molva molva*) and tusk (*Brosme brosme*) are not generally regarded as “true” deep-water fish species although they are found in waters on the upper continental slope between the depths of ca. 200 m-600 m. However, this depth range has some species, including ling and tusk, that are also found in waters less than 200 m deep on the outer continental shelf. Other commercial fish species caught at this depth range that are also found commonly in shallower shelf-sea waters include anglerfish (*Lophius* spp.) and megrim (*Lepidorhombus* spp.).

For the quota-year starting 1 September 2001 and ending 31 August 2002 the agreed national TAC by Iceland is 3 000 t in Division Va.

Landings by ICES Subarea, Division, and nation are given in Table 3.13.3.1.

Source of information: Report of the Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources, 4–10 April 2002 (ICES CM 2002/ACFM:16).

Catch data (Table 3.13.3.1):

Year	ACFM catch
1988	58
1989	52
1990	45
1991	45
1992	41
1993	43
1994	44
1995	50
1996	52
1997	45
1998	55
1999	39
2000*	38
2001*	33

* Preliminary. Weights in '000 t.

Ling (*Molva molva*)

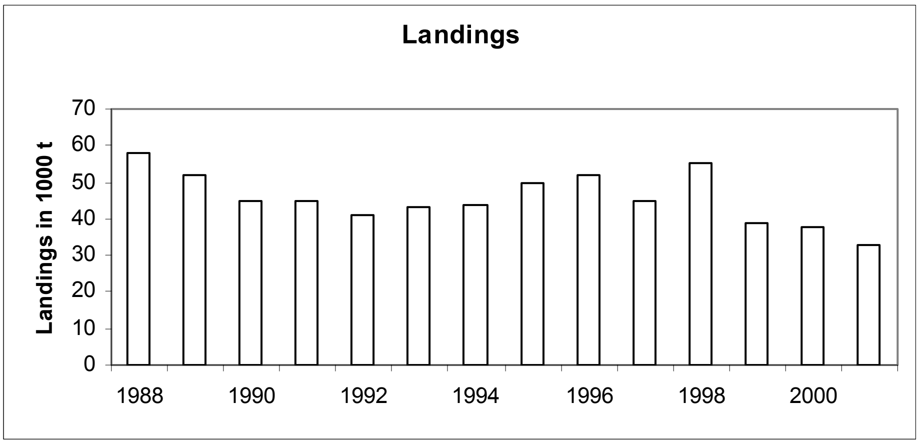


Table 3.13.3.1 Ling (*Molva molva*). Working Group estimates of landings (tonnes).

Ling in Subarea I

Year	Norway	Iceland	Total
1996	136	-	136
1997	31	-	31
1998	123	-	123
1999	64	-	64
2000*	68	1	69
2001*	65	1	66

*Preliminary.

Ling in Division IIa

Year	Faroes	France	Germany	Norway	E & W	Scotland	Total
1988	3	29	10	6,070	4	3	6,119
1989	2	19	11	7,326	10	-	7,368
1990	14	20	17	7,549	25	3	7,628
1991	17	12	5	7,755	4	+	7,793
1992	3	9	6	6,495	8	+	6,521
1993	-	9	13	7,032	39	-	7,093
1994	101	n/a	9	6,169	30	-	6,309
1995	14	6	8	5,921	3	2	5,954
1996	0	2	17	6,059	2	3	6,083
1997	0	15	7	5,343	6	2	5,373
1998	-	13	6	9,049	3	1	9,072
1999	-	11	7	7,557	2	4	7,581
2000*	-	9	39	5,836	5	2	5,891
2001*	-	9	34	4,805	0	3	4,851

*Preliminary.

Ling in Division IIb

Year	Norway	E & W	Total
1988	-	7	7
1989	-	-	-
1990	-	-	-
1991	-	-	-
1992	-	-	-
1993	-	-	-
1994	-	13	13
1995	-	-	-
1996	127	-	127
1997	5	-	5
1998	5	+	5
1999	6	-	6
2000*	4	-	4
2001*	33	-	33

*Preliminary.

Continued …

Table 3.13.3.1 Continued

Ling in Subarea III

Year	Belgium	Denmark	Germany	Norway	Sweden	E & W	Total
1988	2	165	-	135	29	-	331
1989	1	246	-	140	35	-	422
1990	4	375	3	131	30	-	543
1991	1	278	-	161	44	-	484
1992	4	325	-	120	100	-	549
1993	3	343	-	150	131	15	642
1994	2	239	+	116	112	-	469
1995	4	212	-	113	83	-	412
1996	-	212	1	124	65	-	402
1997	-	159	+	105	47	-	311
1998	-	103	-	111	-	-	214
1999	-	101	-	115	-	-	216
2000*	-	101	+	96	31	-	228
2001*	-	125	+	102	25	-	252

*Preliminary.

Ling in Division IVa

Year	Belgium	Denmark	Faroes	France	Germany	Neth.	Norway	Sweden [1]	E&W	NI	Scot.	**Total**
1988	3	408	13	1,143	262	4	6,473	5	55	1	2,856	**11,223**
1989	1	578	3	751	217	16	7,239	29	136	14	2,693	**11,677**
1990	1	610	9	655	241	-	6,290	13	213	-	1,995	**10,027**
1991	4	609	6	847	223	-	5,799	24	197	+	2,260	**9,969**
1992	9	623	2	414	200	-	5,945	28	330	4	3,208	**10,763**
1993	9	630	14	395	726	-	6,522	13	363	-	4,138	**12,810**
1994	20	530	25	n/a	770	-	5,355	3	148	+	4,645	**11,496**
1995	17	407	51	290	425	-	6,148	5	181	-	5,517	**13,041**
1996	8	514	25	241	448	-	6,622	4	193	-	4,650	**12,705**
1997	3	643	6	206	320	-	4,715	5	242	-	5,175	**11,315**
1998	8	558	19	175	176	-	7,069	-	125	-	5,501	**13,631**
1999	16	596	n.a.	293	141	-	5,077	-	240	-	3,447	**9,810**
2000*	20	538	2	146	103	-	4,780	7	74	-	3,576	**9,246**
2001*	-	702	1	115	54	-	3,613	6	60	-	3,290	**7,841**

*Preliminary. [1] Includes IVb 1988-1993.

Ling in Divisions IVb,c

Year	Belgium	Denmark	France	Sweden	Norway	E & W	Scotland	Germany	Total
1988	-	-	-	-	100	173	106	-	379
1989	-	-	-	-	43	236	108	-	387
1990	-	-	-	-	59	268	128	-	455
1991	-	-	-	-	51	274	165	-	490
1992	-	261	-	-	56	392	133	-	842
1993	-	263	-	-	26	412	96	-	797
1994	-	177	-	-	42	40	64	-	323
1995	-	161	-	-	39	301	135	23	659
1996	-	986	-	-	100	187	106	45	1424
1997	33	166	1	9	57	215	170	48	699
1998	47	164	5	-	129	128	136	18	627
1999	35	138	-	-	51	106	106	10	446
2000*	59	101	0	8	45	77	90	4	384
2001*	47	81	0	3	23	62	60	6	282

* Preliminary.

Continued …

Table 3.13.3.1 Continued

Ling in Division Va

Year	Belgium	Faroes	Germany	Iceland	Norway	E & W	Scotland	Total
1988	134	619	-	5,098	10	-	-	5,861
1989	95	614	-	4,898	5	-	-	5,612
1990	42	399	-	5,157	-	-	-	5,598
1991	69	530	-	5,206	-	-	-	5,805
1992	34	526	-	4,556	-	-	-	5,116
1993	20	501	-	4,333	-	-	-	4,854
1994	3	548	+	4,053	-	-	-	4,604
1995	-	463	+	3,729	-	-	-	4,192
1996	-	358	-	3,670	20	12	-	4,060
1997	-	299	-	3,634	0	-	-	3,933
1998	-	699	-	3,603	-	-	-	4,302
1999	-	542	+	3,980	120	4	1	4.647
2000*	-	452	+	3,221	67	3	+	3,743
2001*	-	333	2	2,864	117	4	+	3,320

*Preliminary.

Ling in Subdivision Vb_1

Year	Denmark	Faroes	France [2]	Germany	Norway	E&W [1]	Scotland [1]	Total
1988	42	1,383	53	4	884	1	5	2,372
1989	-	1,498	44	2	1,415	-	3	2,962
1990	-	1,575	36	1	1,441	+	9	3,062
1991	-	1,828	37	2	1,594	-	4	3,465
1992	-	1,218	3	+	1,153	15	11	2,400
1993	-	1,242	5	1	921	62	11	2,242
1994	-	1,541	6	13	1,047	30	20	2,657
1995	-	2,789	4	13	446	2	32	3,286
1996	-	2,672	-	-	1,284	12	28	3,996
1997	-	3,224	7	-	1,428	34	40	4,733
1998	-	2,422	6	-	1,452	4	145	4,029
1999	-	2,446	22	3	2,034	0	71	4,576
2000*	-	1,942	9	1	1,305	2	61	3,320
2001*	-	2,206	17	3	1,496	0	99	3,821

*Preliminary. [1] Includes Vb_2. [2] Includes Vb_2 and Va. [3] Reported as Vb.

Ling in Subdivision Vb_2

Year	Faroes	Norway	Total
1988	832	1,284	2,116
1989	362	1,328	1,690
1990	162	633	795
1991	492	555	1,047
1992	577	637	1,214
1993	282	332	614
1994	479	486	965
1995	281	503	784
1996	102	798	900
1997	526	398	924
1998	511	819	1,330
1999	164	498	662
2000*	-	399	399
2001*	182	497	679

*Preliminary. [1] Included in Vb_1.

Continued …

Table 3.13.3.1 Continued

Ling in Division VIa

Year	Belgium	Denmark	Faroes	France [1]	Germany	Ireland	Norway	Spain [2]	E&W	IOM	N.I.	Scot.	Total
1988	4	+	-	5,381	6	196	3,392	3,575	1,075	-	53	874	14,556
1989	6	1	6	3,417	11	138	3,858	-	307	+	6	881	8,631
1990	-	+	8	2,568	1	41	3,263	-	111	-	2	736	6,730
1991	3	+	3	1,777	2	57	2,029	-	260	-	10	654	4,795
1992	-	1	-	1,297	2	38	2,305	-	259	+	6	680	4,588
1993	+	+	-	1,513	92	171	1,937	-	442	-	13	1,133	5,301
1994	1	1	-	1,713	134	133	2,034	1,027	551	-	10	1,126	6,730
1995	-	2	0	1,970	130	108	3,156	927	560	n/a	-	1,994	8,847
1996	-	-	0	1,762	370	106	2,809	1,064	269	-	-	2,197	8,577
1997	-	-	0	1,631	135	113	2,229	37	151	-	-	2,450	6,746
1998	-	-	-	1,531	9	72	2,910	292	154	-	-	2,394	7,362
1999	-	-	-	941	4	73	2,997	468	152	-	-	2,264	6,899
2000*	+	+	-	717	3	75	2,956	359	143	-	-	2,287	6,240
2001*	-	-	-	720	3	70	1,869	129	106	-	-	2,179	5,076

*Preliminary. [1] Includes VIb until 1996. [2] Includes minor landings from VIb.

Ling in Division VIb

Year	Faroes	France [1]	Germany	Ireland	Norway	Spain [2]	E & W	N.I.	Scotland	Russia	Total
1988	196	-	-	-	1,253	…	93	-	223	-	1,765
1989	17	-	-	-	3,616	…	26	-	84	-	3,743
1990	3	-	-	26	1,315	…	10	+	151	-	1,505
1991	-	-	-	31	2,489	…	29	2	111	-	2,662
1992	35	-	+	23	1,713	…	28	2	90	-	1,891
1993	4	-	+	60	1,179	…	43	4	232	-	1,522
1994	104	-	-	44	2,116	…	52	4	220	-	2,540
1995	66	-	+	57	1,308	…	84	-	123	-	1,638
1996	0	-	124	70	679	…	150	-	101	-	1,124
1997	0	-	46	29	504	…	103	-	132	-	814
1998	-	1	10	44	944	…	71	-	324	-	1,394
1999	-	26	25	41	498	…	86	-	499	-	1,175
2000*	+	18	31	19	1,172	…	157	-	475	7	1,879
2001*	-	16	3	18	328	…	116	-	307	-	788

*Preliminary. [1] Until 1966 included in VIa. [2] Included in VIa.

Ling in Subarea VII

Year	France	Total
1988	5,057	5,057
1989	5,261	5,261
1990	4,575	4,575
1991	3,977	3,977
1992	2,552	2,552
1993	2,294	2,294
1994	2,185	2,185
1995	[1]	
1996	[1]	
1997	[1]	
1998	[1]	
1999	[1]	
2000	[1]	
2001	[1]	

[1] Reported by Division. Continued …

Table 3.13.3.1 Continued

Ling in Division VIIa

Year	Belgium	France	Ireland	E & W	IOM	N.I.	Scotland	**Total**
1988	14	(1)	100	49	-	38	10	**211**
1989	10	(1)	138	112	1	43	7	**311**
1990	11	(1)	8	63	1	59	27	**169**
1991	4	(1)	10	31	2	60	18	**125**
1992	4	(1)	7	43	1	40	10	**105**
1993	10	(1)	51	81	2	60	15	**219**
1994	8	(1)	136	46	2	76	16	**284**
1995	12	9	143	106	1	(2)	34	**305**
1996	11	6	147	29	-	(2)	17	**210**
1997	8	6	179	59	2	(2)	10	**264**
1998	7	7	89	69	1	(2)	25	**198**
1999	7	3	32	29	-	(2)	13	**84**
2000*	3	2	18	25	-	(2)	25	**73**
2001*	-	3	33	20	-	(2)	31	**87**

*Preliminary. (1) French catches in VII not split into divisions, see Subarea VII. (2) Included with E & W.

Ling in Divisions VIIb,c

Year	France	Germany	Ireland	Norway	Spain (3)	E & W	N.I.	Scotland	Total
1988	(1)	-	50	57	…	750	-	8	865
1989	(1)	+	43	368	…	161	-	5	577
1990	(1)	-	51	463	…	133	-	31	678
1991	(1)	-	62	326	…	294	8	59	749
1992	(1)	-	44	610	…	485	4	143	1,286
1993	(1)	97	224	145	…	550	9	409	1,434
1994	(1)	98	225	306	…	530	2	434	1,595
1995	78	161	465	295	…	630	(2)	315	1,944
1996	57	234	283	168	…	1,117	(2)	342	2,201
1997	65	252	184	418	…	635	(2)	226	1,780
1998	32	1	190	89	…	393	(2)	329	1,034
1999	50	4	377	288	…	488	(2)	159	1,366
2000*	116	21	401	170	…	327	(2)	140	1,175
2001*	71	2	413	515	…	94	(2)	122	1,217

*Preliminary. (1) See Subarea VII. (2) Included with E & W. (3) Included in VIIg-k.

Ling in Divisions VIId,e

Year	Belgium	Denmark	France	Ireland	E & W	Scotland	Ch. Islands	Total
1988	36	+	(1)	-	743	-	-	779
1989	52	-	(1)	-	644	4	-	700
1990	31	-	(1)	22	743	3	-	799
1991	7	-	(1)	25	647	1	-	680
1992	10	+	(1)	16	493	+	-	519
1993	15	-	(1)	-	421	+	-	436
1994	14	+	(1)	-	437	0	-	451
1995	10	-	885	2	492	0	-	1,389
1996	15	-	960	-	499	3	-	1,477
1997	12	-	1,049	1	372	1	37	1,472
1998	10	-	953	-	510	1	26	1,500
1999	7	-	538	-	507	1	-	1,053
2000*	5	-	446	1	372	+	14	837
2001*	-	-	384	-	399	-	-	783

*Preliminary. (1) See Subarea VII.

Continued …

Table 3.13.3.1 Continued

Ling in Division VIIf

Year	Belgium	France	Ireland	E & W	Scotland	Total
1988	77	(1)	-	367	-	444
1989	42	(1)	-	265	3	310
1990	23	(1)	3	207	-	233
1991	34	(1)	5	259	4	302
1992	9	(1)	1	127	-	137
1993	8	(1)	-	215	+	223
1994	21	(1)	-	379	-	400
1995	36	110	-	456	0	602
1996	40	121	-	238	0	399
1997	30	204	-	313	-	547
1998	29	204	-	328	-	561
1999	16	108	-	188	-	312
2000*	15	90	1	111	-	217
2001*	-	110	-	92	-	202

*Preliminary. (1) See SubareaVII.

Ling in Divisions VIIg-k

Year	Belgium	Denmark	France	Germany	Ireland	Norway	Spain (2)	E&W	IOM	N.I.	Scotland	Total
1988	35	1	(1)	-	286	-	2,652	1,439	-	-	2	4,415
1989	23	-	(1)	-	301	163	-	518	-	+	7	1,012
1990	20	+	(1)	-	356	260	-	434	+	-	7	1,077
1991	10	+	(1)	-	454	-	-	830	-	-	100	1,394
1992	10	-	(1)	-	323	-	-	1,130	-	+	130	1,593
1993	9	+	(1)	35	374	-	-	1,551	-	1	364	2,334
1994	19	-	(1)	10	620	-	184	2,143	-	1	277	3,254
1995	33	-	1,597	40	766	-	195	3,046	-	(3)	454	6,131
1996	45	-	1,626	169	771	-	583	3,209	-	(3)	447	6,850
1997	37	-	1,574	156	674	-	33	2,112	-	(3)	459	5,045
1998	18	-	1,362	88	877	-	1,669	3,465	-	(3)	335	7,814
1999	-	-	1,229	49	554	-	455	1,619	-	(3)	292	4,198
2000*	17	-	1,006	12	624	-	518	921	-	(3)	303	3,401
2001*	-	-	963	4	727	24	490	591	-	(3)	285	3,084

*Preliminary. (1) See Subarea VII. (2) Includes VIIb,c. (3) Included in E & W.

Ling in Subarea VIII

Year	Belgium	France	Germany	Spain	E & W	Scotland	Total
1988	-	1,018	-	-	10	-	1,028
1989	-	1,214	-	-	7	-	1,221
1990	-	1,371	-	-	1	-	1,372
1991	-	1,127	-	-	12	-	1,139
1992	-	801	-	-	1	-	802
1993	-	508	-	-	2	-	510
1994	-	n/a	-	77	8	-	85
1995	-	693	-	106	46	-	845
1996	-	825	23	170	23	-	1,041
1997	1	705	+	290	38	-	1,034
1998	5	1,220	-	543	29	-	1,797
1999	22	232	-	188	8	-	450
2000*	1	218	-	56	5	-	280
2001*	-	167	-	333	7	2	509

*Preliminary. Continued …

Table 3.13.3.1 Continued

Ling in Subarea IX

Year	Spain	Total
1997	0	0
1998	2	2
1999	1	1
2000*	1	1
2001*	0	0

*Preliminary.

Ling in Subarea XII

Year	Faroes	France	Norway	E & W	Scotland	Germany	Ireland	Total
1988	-	-	-	-	-	-	-	0
1989	-	-	-	-	-	-	-	0
1990	-	-	-	3	-	-	-	3
1991	-	-	-	10	-	-	-	10
1992	-	-	-	-	-	-	-	0
1993	-	-	-	-	-	-	-	0
1994	-	-	-	5	-	-	-	5
1995	5	-	-	45	-	-	-	50
1996	-	-	2	-	-	-	-	2
1997	-	-	+	9	-	-	-	9
1998	-	1	-	1	-	-	-	2
1999	-	0	-	-	+	2	-	2
2000*	-	1	-	-	6	-	-	7
2001*	-	0	29	2	24	-	4	59

*Preliminary.

Ling in Subarea XIV

Year	Faroes	Germany	Iceland	Norway	E & W	Scotland	Total
1988	-	3	-	-	-	-	3
1989	-	1	-	-	-	-	1
1990	-	1	-	2	6	-	9
1991	-	+	-	+	1	-	1
1992	-	9	-	7	1	-	17
1993	-	-	+	1	8	-	9
1994	-	+	-	4	1	1	6
1995	-	-	-	14	3	0	17
1996	-	-	-	0	-	-	0
1997	1	-	-	60	-	-	61
1998	-	-	-	6	-	-	6
1999	-	-	-	1	-	-	1
2000*	-	-	26	-	-	-	26
2001*	-	-	-	35	-	-	35

*Preliminary.

Table 3.13.3.1. Continued

LING, total landings by Subareas or Division.

Year	I	IIa	IIb	III	IVa	IVb,c	Va	Vb1	Vb2	VIa	VIb	VII**	VIIa	VIIb,c	VIId,e	VIIf	VIIg-k	VIII	IX	XII	XIV	All areas
1988		6,119	7	331	11,223	379	5,861	2,372	2,116	14,556	1,765	5,057	211	865	779	444	4,415	1,028		0	3	57,531
1989		7,368		422	11,677	387	5,612	2,962	1,690	8,631	3,743	5,261	311	577	700	310	1,012	1,221		0	1	51,885
1990		7,628		543	10,027	455	5,598	3,062	795	6,730	1,505	4,575	169	678	799	233	1,077	1,372		3	9	45,258
1991		7,793		484	9,969	490	5,805	3,465	1,047	4,795	2,662	3,977	125	749	680	302	1,394	1,139		10	1	44,887
1992		6,521		549	10,763	842	5,116	2,400	1,214	4,588	1,891	2,552	105	1,286	519	137	1,593	802		0	17	40,895
1993		7,093		642	12,810	797	4,854	2,242	614	5,301	1,522	2,294	219	1,434	436	223	2,334	510		0	9	43,334
1994		6,309	13	469	11,496	323	4,604	2,657	965	6,730	2,540	2,185	284	1,595	451	400	3,254	85		5	6	44,371
1995		5,954		412	13,041	659	4,192	3,286	784	8,847	1,638		305	1,944	1,389	602	6,131	845		50	17	50,096
1996	136	6,083	127	402	12,705	1,424	4,060	3,996	900	8,577	1,124		210	2,201	1,477	399	6,850	1,041		2	0	51,714
1997	31	5,373	5	311	11,315	699	3,933	4,733	924	6,746	814		264	1,780	1,472	547	5,045	1,034	0	9	61	45,096
1998	123	9,072	5	214	13,631	627	4,302	4,029	1,330	7,362	1,394		198	1,034	1,500	561	7,814	1,797	2	2	6	55,003
1999	64	7,581	6	216	9,810	446	4.647	4,576	662	6,899	1,175		84	1,366	1,053	312	4,198	450	1	2	1	38,907
2000*	69	5,891	4	228	9,246	384	3,743	3,320	399	6,540	1,879		73	1,175	838	217	3,401	280	1	7	26	37,721
2001*	66	4,851	33	252	7,841	282	3,320	3,821	679	5,076	788		87	1,217	783	202	3,084	509	0	59	35	32,985

*Preliminary.

** Fraction of landings
from VII not given by Division

3.13.4 Tusk (*Brosme brosme*)

State of the stock/exploitation: The state of the stock is highly uncertain due to the lack of relevant CPUE data for the major fisheries in the most recent years. Previously presented mortality estimates from several areas for the last decade were high. The fleet and the catches have increased and the fishing areas and practices are the same, therefore it is unlikely that the exploitation rate has decreased in recent years. The stock may therefore remain outside safe biological limits. In 2000, it was concluded that the exploitable stock biomass would appear to be less than 20% of virgin biomass and fishing mortality was relatively high. CPUE series from the fishery and groundfish survey in Division Va presented in 2002 suggests a pronounced decline in recent years also in that area (Figures 3.13.4.1–2).

Advice on management: ICES recommends that the overall fishing effort be reduced by 30%.

Relevant factors to be considered in management: Tusk is more vulnerable to over-exploitation than ling, due to a slower growth rate and high age at maturity. Most of the tusk landings are by-catch in ling fisheries and therefore the reductions recommended for that species should facilitate the advised reductions for tusk.

Landings are mainly by-catches in longline fisheries directed at ling and blue ling in Divisions IIa, Va, Vb and VIa. In Division Vb tusk is also taken as a by-catch in trawl fisheries.

Comparison with previous assessment and advice: No comparison of assessments was possible. In Division Va, the survey index from the Icelandic groundfish survey suggests a pronounced declining abundance.

Elaboration and special comment: Landings by Subarea/Division and nation are given in Table 3.13.4.1.

Ling (*Molva molva*) and tusk (*Brosme brosme*) are not generally regarded as “true” deep-water fish species although they are found in waters on the upper continental slope between the depths of ca. 200 m-600 m. However, this depth range has some species, including ling and tusk, that are also found in waters less than 200 m deep on the outer continental shelf. Other commercial fish species caught in this depth range that are also found commonly in shallower shelf-sea waters include anglerfish (*Lophius* spp.) and megrim (*Lepidorhombus* spp.).

For the quota-year starting 1 September 2001 and ending 31 August 2002 the agreed national TAC by Iceland is 4 500 t in Division Va.

Source of information: Report of the Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources, 4–10 April 2002 (ICES CM 2002/ACFM:16).

Catch data (Table 3.13.4.1):

Year	ACFM Catch
1988	34
1989	42
1990	40
1991	41
1992	37
1993	35
1994	29
1995	28
1996	29
1997	23
1998	29
1999	33
2000*	31
2001*	27

[1]Preliminary. Weights in '000 t.

Tusk (*Brosme brosme*)

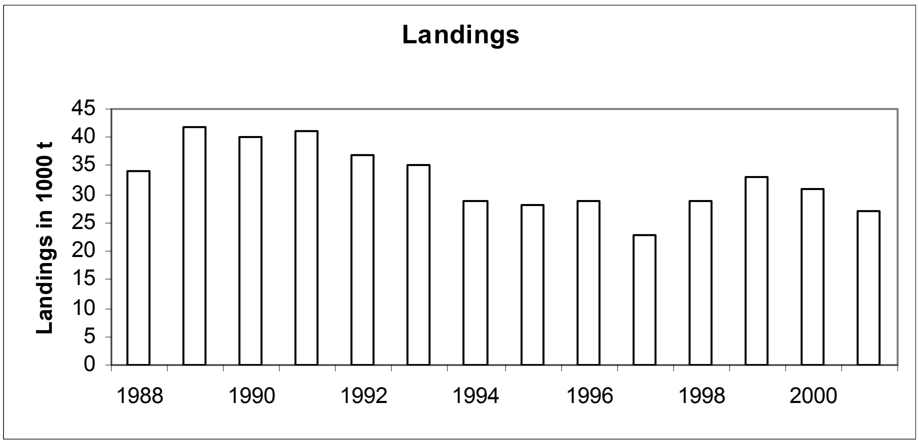


Table 3.13.4.1 Tusk (*Brosme brosme*). Working Group estimates of landings (tonnes).

Tusk in Subarea I

Year	Norway	Russia	Faroes	Iceland	Total
1996	587	-	-	-	587
1997	665	-	-	-	665
1998	805	-	-	-	805
1999	907	-	-	-	907
2000*	738	43	1	16	798
2001*	595	6	-	13	614

* Preliminary.

Tusk in Division IIa

Year	Faroes	France	Germany	Greenland	Norway	E & W	Scotland	Russia	Ireland	Total
1988	115	32	13	-	14,241	2	-	-	-	14,403
1989	75	55	10	-	19,206	4	-	-	-	19,350
1990	153	63	13	-	18,387	12	+	-	-	18,628
1991	38	32	6	-	18,227	3	+	-	-	18,306
1992	33	21	2	-	15,908	10	-	-	-	15,974
1993	-	23	2	11	17,545	3	+	-	-	17,584
1994	281	14	2	-	12,266	3	-	-	-	12,566
1995	77	16	3	20	11,271	1	-	-	-	11,388
1996	0	12	5	-	12,029	1	-	-	-	12,047
1997	1	21	1	-	8,642	2	+	-	-	8,667
1998	-	9	1	-	14,463	1	1	-	-	14,475
1999	-	7	+	-	16,213	-	2	28	-	16,250
2000*	-	8	1	-	13,120	3	2	58	-	13,192
2001*	-	15	+	-	11,200	1	3	66	5	11,290

* Preliminary.

Tusk in Division IIb

Year	Norway	E & W	Russia	Total
1988	-	-	-	0
1989	-	-	-	0
1990	-	-	-	0
1991	-	-	-	0
1992	-	-	-	0
1993	-	1	-	1
1994	-	-	-	0
1995	229	-	-	229
1996	161		-	161
1997	92	2	-	94
1998	73	+	-	73
1999	26	-	4	26
2000*	15	-	3	18
2001*	141	-	5	146

* Preliminary.

Continued …

Table 3.13.4.1 Continued

Tusk in Division IIIa

Year	Denmark	Norway	Sweden	Total
1988	8	51	2	61
1989	18	71	4	93
1990	9	45	6	60
1991	14	43	27	84
1992	24	46	15	85
1993	19	48	12	79
1994	6	33	12	51
1995	4	33	5	42
1996	6	32	6	44
1997	3	25	3	31
1998	2	19	-	21
1999	4	25	-	29
2000*	8	23	5	36
2001*	10	41	-	51

*Preliminary.

Tusk in Division Iva

Year	Denmark	Faroes	France	Germany	Norway	Sweden[1]	E & W	N.I.	Scotland	Ireland	Total
1988	83	1	201	62	3,998	-	12	-	72	-	4,429
1989	86	1	148	53	6,050	+	18	+	62	-	6,418
1990	136	1	144	48	3,838	1	29	-	57	-	4,254
1991	142	12	212	47	4,008	1	26	-	89	-	4,537
1992	169	-	119	42	4,435	2	34	-	131	-	4,932
1993	102	4	82	29	4,768	+	9	-	147	-	5,141
1994	82	4	86	27	3,001	+	24	-	151	-	3,375
1995	81	6	68	24	2,988	-	10	-	171	-	3,348
1996	120	8	49	47	2,970	-	11	-	164	-	3,369
1997	189	0	47	19	1,763	+	16	-	238	-	2,272
1998	114	3	38	12	2,943	-	11	-	266	-	3,387
1999	165	7	44	10	1,983	-	12	-	213	1	2,435
2000*	208	+	32	10	2,651	2	12	-	343	1	3,259
2001*	258	-	26	8	2,443	-	10	-	343	1	3,089

* Preliminary. (1) Includes IVb 1988–1993.

Tusk in Division IVb

Year	Denmark	France	Norway	Germany	E & W	Scotland	Total
1988	-	n/a	-	-	-	-	-
1989	-	3	-	-	1	-	4
1990	-	5	-	-	-	-	5
1991	-	2	-	-	-	-	2
1992	10	1	-	-	1	-	12
1993	13	1	-	-	-	-	14
1994	4	1	-	-	2	-	7
1995	4	-	5	1	3	2	15
1996	134[1]	-	21	4	3	1	163
1997	6	1	24	2	2	3	38
1998	4	0	55	1	3	3	66
1999	8	-	21	1	1	3	34
2000*	8	-	106	+	-	2	116
2001*	6	-	45[1]	1	1	3	56

* Preliminary. (1) Includes IVc.

Continued …

Table 3.13.4.1 Continued

Tusk in Division Va

Year	Faroes	Germany	Iceland	Norway	Scotland	E & W	Total
1988	3,757	-	3,078	20	-	-	6,855
1989	3,908	-	3,143	10	-	-	7,061
1990	2,475	-	4,816	-	-	-	7,291
1991	2,286	-	6,446	-	-	-	8,732
1992	1,567	-	6,442	-	-	-	8,009
1993	1,329	-	4,746	-	-	-	6,075
1994	1,212	-	4,612	-	-	-	5,824
1995	979	1	5,245	-	-	-	6,225
1996	872	1	5,226	3	-	-	6,102
1997	575	-	4,819	-	-	-	5,394
1998	1,052	1	4,118	0	-	-	5,171
1999	1,075	2	5,795	391	1	-	7,264
2000*	1,302	+	4,714	374	+	1	6,391
2001*	1,049	1	3,407	285	+	1	4,743

*Preliminary.

Tusk in Subdivision Vb_1

Year	Denmark	Faroes	France	Germany	Norway	E & W	Scotland [1]	Russia	Total
1988	+	2,827	81	8	1,143	-	-	-	4,059
1989	-	1,828	64	2	1,828	-	-	-	3,722
1990	-	3,065	66	26	2,045	-	-	-	5,202
1991	-	3,829	19	1	1,321	-	-	-	5,170
1992	-	2,796	11	2	1,590	-	-	-	4,399
1993	-	1,647	9	2	1,202	2	-	-	2,862
1994	-	2,649	8	1 [2]	747	2	-	-	3,407
1995	-	3,059	16	1 [2]	270	1	-	-	3,347
1996	-	1,636	8	1	1,083	-	-	-	2,728
1997	-	1,849	11	+	869	-	13	-	2,742
1998	-	1,272	20	-	753	1	27	-	2,073
1999	-	1,956	27	1	1,522	-	11[3]	-	3,517
2000*	-	1,316	13	1	1,191	1	11[3]	1	2,534
2001*	-	1,779	13	1	1,572	-	20[3]	-	3,385

* Preliminary. [1] Included in Vb_2 until 1996. [2]) Includes Vb_2. [3] Reported as Vb.

Tusk in Subdivision Vb_2

Year	Faroes	Norway	E & W	Scotland [1]	Total
1988	545	1,061	-	+	1,606
1989	163	1,237	-	+	1,400
1990	128	851	-	+	979
1991	375	721	-	+	1,096
1992	541	450	-	1	992
1993	292	285	-	+	577
1994	445	462	+	2	909
1995	225	404	[2]	2	631
1996	46	536	-	-	582
1997	157	420	-	-	577
1998	107	530	-	-	637
1999	132	315	-	-	447
2000*	108	333	-	-	441
2001*	150	469	-	-	619

* Preliminary. [1] Includes Vb_1. [2] See Vb_1. Continued …

Table 3.13.4.1 Continued

Tusk in Division VIa

Year	Denmark	Faroes	France [1]	Germany	Ireland	Norway	E & W	N.I.	Scotland	Spain	Total
1988	-	-	766	1	-	1,310	30	-	13	-	2,120
1989	+	6	694	3	2	1,583	3	-	6	-	2,297
1990	-	9	723	+	-	1,506	7	+	11	-	2,256
1991	-	5	514	+	-	998	9	+	17	-	1,543
1992	-	-	532	+	-	1,124	5	-	21	-	1,682
1993	-	-	400	4	3	783	2	+	31	-	1,223
1994	+	-	345	6	1	865	5	-	40	-	1,262
1995	-	0	332	+	33	990	1	-	79	-	1,435
1996	-	0	368	1	5	890	1	-	126	-	1,391
1997	-	0	359	+	3	750	1	-	137	11	1,261
1998	-	-	395	+	-	715	-	-	163	8	1,281
1999	-	-	193	+	3	113	1	-	182	47	539
2000*	-	-	238	+	20	1,327	8	-	231	75	1,899
2001*	-	-	162	+	31	1,201	8	-	279	33	1,714

* Preliminary. [1] Not allocated by divisions before 1993.

Tusk in Division VIb

Year	Faroes	France	Germany	Ireland	Iceland	Norway	E & W	N.I.	Scotland	Russia	Total
1988	217	-	-	-	-	601	8	-	34	-	860
1989	41	1	-	-	-	1,537	2	-	12	-	1,593
1990	6	3	-	-	-	738	2	+	19	-	768
1991	-	7	+	5	-	1,068	3	-	25	-	1,108
1992	63	2	+	5	-	763	3	1	30	-	867
1993	12	3	+	32	-	899	3	+	54	-	1,003
1994	70	1	+	30	-	1,673	6	-	66	-	1,846
1995	79	1	+	33	-	1,415	1	-	35	-	1,564
1996	0	1	-	30	-	836	3	-	69	-	939
1997	1	1	-	23	-	359	2	-	90	-	476
1998	-	1	-	24	18	630	9	-	233	-	915
1999	-	-	-	26	-	591	5	-	331	-	953
2000*	-	2	-	22	-	1,933	14	-	372	1	2,344
2001*	-	1	-	31	-	476	10	-	157	5	680

* Preliminary.

Tusk in Division VIIa

Year	France	E & W	Scotland	Total
1988	n/a	-	+	+
1989	2	-	+	2
1990	4	+	+	4
1991	1	-	1	2
1992	1	+	2	3
1993	-	+	+	+
1994	-	-	+	+
1995	-	-	1	1
1996	-	-	-	-
1997	-	-	1	1
1998	-	-	1	1
1999	-	-	+	+
2000*	-	-	+	+
2001*	-	-	1	+

* Preliminary.

Continued …

Table 3.13.4.1 Continued

Tusk in Divisions VIIb,c

Year	France	Ireland	Norway	E & W	N.I.	Scotland	Total
1988	n/a	-	12	5	-	+	17
1989	17	-	91	-	-	-	108
1990	11	3	138	1	-	2	155
1991	11	7	30	2	1	1	52
1992	6	8	167	33	1	3	218
1993	6	15	70	17	+	12	120
1994	5	9	63	9	-	8	94
1995	3	20	18	6	-	1	48
1996	4	11	38	4	-	1	58
1997	4	8	61	1	-	1	75
1998	3	-	28	-	-	2	33
1999	-	16	130	-	-	1	147
2000*	3	58	88	12	-	3	164
2001*	3	54	177	4	-	25	263

*Preliminary.

Tusk in Divisions VIIg-k

Year	France	Germany	Ireland	Norway	E & W	Scotland	Spain	Total
1988	n/a	-	-	-	5	-	-	5
1989	3	-	-	82	1	-	-	86
1990	6	-	-	27	0	+	-	33
1991	4	-	-	-	8	2	-	14
1992	9	-	-	-	38	-	-	47
1993	5	-	17	-	7	3	-	32
1994	4	-	12	-	12	3	-	31
1995	3	-	8	-	18	8	-	37
1996	3	-	20	-	3	3	-	29
1997	4	4	11	-	-	+	0	19
1998	2	3	4	-	-	1	0	10
1999	1	1	-	-	-	+	6	8
2000*	3	-	5	-	-	+	3	11
2001*	3	-	-	9	-	+	2	14

* Preliminary.

Tusk in Division VIIIa

Year	E & W	France	Total
1988	1	n/a	1
1989	-	-	-
1990	-	-	-
1991	-	-	-
1992	-	-	-
1993	-	-	-
1994	-	-	-
1995	-	-	-
1996	-	-	-
1997	+	+	+
1998	-	1	1
1999	-	-	0
2000*	-	-	-
2001*	-	-	-

* Preliminary. Continued …

Table 3.13.4.1 Continued

Tusk in Subarea XII

Year	Faroes	France	Iceland	Norway	Scotland	Total
1988		1				1
1989		1				1
1990		0				0
1991		1				1
1992		1				1
1993		12	+			12
1994		1	+			1
1995	8	-	10			18
1996	7	-	9	142		158
1997	11	-	+	19		30
1998		1		-		1
1999		1		+	1	1
2000*				5	+	5
2001*				51	+	51

*Preliminary.

Tusk in Division XIVa

Year	Germany	Norway	Total
1988	2	-	2
1989	1	-	1
1990	2	-	2
1991	2	-	2
1992	+	-	+
1993	+	-	+
1994	-	-	-
1995	-	-	-
1996	-	-	-
1997	-	-	-
1998	-	-	-
1999	-	+	+
2000*	-	-	-
2001*	-	0	0

* Preliminary.

Tusk in Division XIVb

Year	Faroes	Iceland	Norway	E & W	Total
1988	-		-	-	-
1989	19	3	-	-	22
1990	13	10	7	-	30
1991	-	64	68	1	133
1992	-	82	120	+	202
1993	-	27	53	+	80
1994	-	9	16	+	25
1995	-	57	30	+	87
1996	-	139	142	-	281
1997	-	10	108	-	118
1998	1	-	14	-	15
1999	-	n/a	9	-	9
2000*	-	-	11	-	11
2001*	-	-	69	-	69

*Preliminary.

Continued …

Table 3.13.4.1 Continued

TUSK - Total landings by area/division and grand total

Year	I	IIa	IIb	III	IVa	IVb	Va	Vb_1	Vb_2	VIa	VIb	VIIa	VIIb,c	VIIg-k	VIIIa	XII	XIVa	XIVb	Total
1988	-	14403	0	61	4429	0	6855	4059	1606	2120	860	-	17	5	1	1	2	0	34,419
1989	-	19350	0	93	6418	4	7061	3722	1400	2297	1593	2	108	86	-	1	1	22	42,158
1990	-	18628	0	60	4254	5	7291	5202	979	2256	768	4	155	33	-	0	2	30	39,667
1991	-	18306	0	84	4537	2	8732	5170	1096	1543	1108	2	52	14	-	1	2	133	40,782
1992	-	15974	0	85	4932	12	8009	4399	992	1682	867	3	218	47	-	1	-	202	37,423
1993	-	17584	1	79	5141	14	6075	2862	577	1223	1003	-	120	32	-	12	-	80	34,803
1994	-	12566	0	51	3375	7	5824	3407	909	1262	1846	-	94	31	-	1	-	25	29,398
1995	-	11388	229	42	3348	15	6225	3347	631	1435	1564	1	48	37	-	18	-	87	28,415
1996	587	12047	161	44	3369	163	6102	2728	582	1391	939	-	58	29	-	158	-	281	28,639
1997	665	8667	94	31	2272	38	5394	2742	577	1261	476	1	75	19	-	30	-	118	22,460
1998	805	14475	73	21	3387	66	5171	2073	637	1281	915	1	33	10	1	1	-	15	28,965
1999	907	16250	26	29	2435	34	7264	3517	447	539	953	-	147	15	0	1	-	9	32,573
2000*	798	13192	18	36	3259	116	6391	2534	441	1899	2344	-	164	8	-	5	-	11	31,216
2001*	614	11290	146	51	3089	56	4743	3385	619	1714	680	1	263	11	-	51	-	69	26,782

* Preliminary

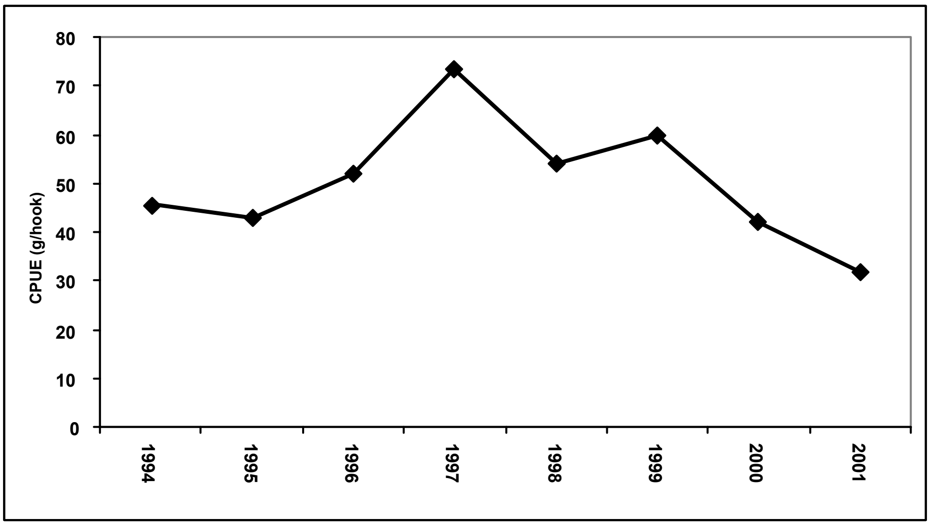


Figure 3.13.4.1. Tusk CPUE from Icelandic longline fishery.

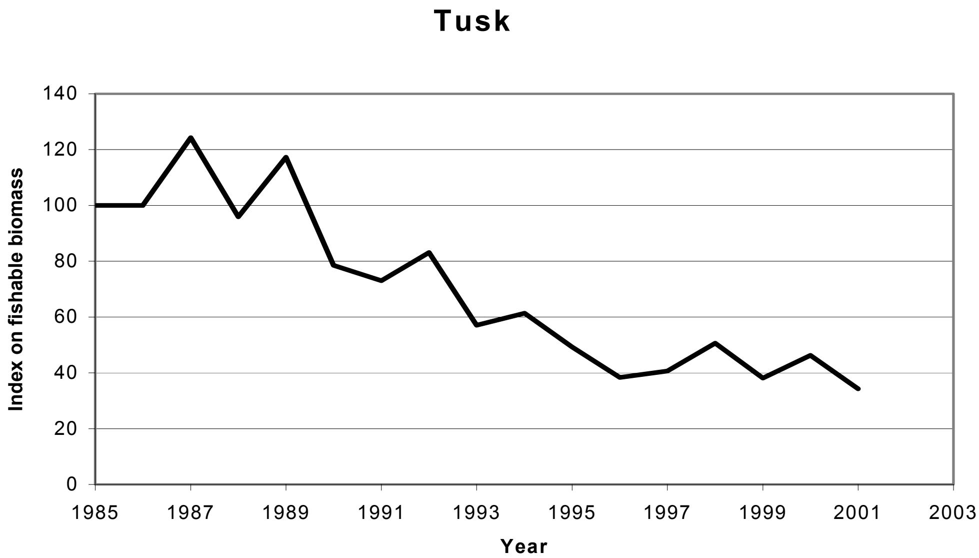


Figure 3.13.4.2 Tusk. Index on fishable biomass calculated from the Icelandic groundfish survey at the Icelandic shelf.

3.13.5 Roundnose grenadier (*Coryphaenoides rupestris*)

State of the stock/exploitation: The state of the stock in Subareas VI and VII and Division Vb is uncertain. The state of the stock in other Subareas or Divisions, including IIIa, is also unknown. The observed increasing CPUE over recent years in Division Va and Subareas VI and VII is believed to reflect a change in the fleet distribution and not an increase of the stock size. Since 1997, a major component of the landings have come from Subarea XII where no CPUE data series were available.

Advice on management: ICES recommends regulation of the fishery in all areas in order to control fishing effort. For Subareas VI and VII and Divisions Vb and IIIa significant reductions on effort are necessary. In all other areas, the expansion of fisheries should not be allowed until reliable assessments indicate that increased harvests are sustainable.

Relevant factors to be considered in management: The current interpretation of recent changes in the CPUE series mean that the CPUE series are not informative about the size of the effort reduction necessary to allow rebuilding to commence. However, for a species with the low productivity, characteristic for the roundnose grenadier, a reduction in the effort of 50%, as advised in 2000, would be appropriate to provide a likelihood of allowing rebuilding to commence.

The fishing effort directed to deep waters varies with time between areas. The recent increase in CPUE in Division Vb and Subareas VI and VII is likely to reflect a change in the fishing strategy, in the geographical distribution of effort, or in the fish accessibility.

Over time the average size and the proportion of large individuals in the landings have decreased.

In most areas, roundnose grenadier is the target species of a mixed trawl fishery.

The distribution of the species extends beyond the depths exploited by the commercial fisheries.

Due to its biological parameters, the species can only sustain a low fishing mortality and recovery of depleted stock(s) is expected to be slow. Therefore, the lack of assessment should not delay the implementation of a management regime for roundnose grenadier.

Comparison with previous assessment and advice: In Subareas VI and VII and Division Vb, the previous assessment lead to the conclusion that the stock was below U_{pa} and possibly close to U_{lim}. No new analytical assessment was accepted and increases in CPUE were believed to be the consequence of changes in the fleet strategy, geographical distribution of effort, or fish accessibility.

Elaboration and special comment: No production model could be fit to the time-series in Subareas VI and VII and Division Vb, due to a new point in the CPUE data. The reasons for the changes in the CPUE should be clarified and further analysis of trends in the fishery are required.

Landings by Subarea/Division and nation are given in Tables 3.13.5.1.

Source of information: Report of the Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources, 4–10 April 2002 (ICES CM 2002/ACFM:16).

Catch data (Table 3.13.5.1):

Year	ACFM Catch
1988	11
1989	13
1990	12
1991	20
1992	17
1993	16
1994	11
1995	10
1996	12
1997	17
1998	22
1999	22
2000	23
2001*	25

* Preliminary. Weights in '000 t

.

Roundnose grenadier (*Coryphaenoides rupestris*)

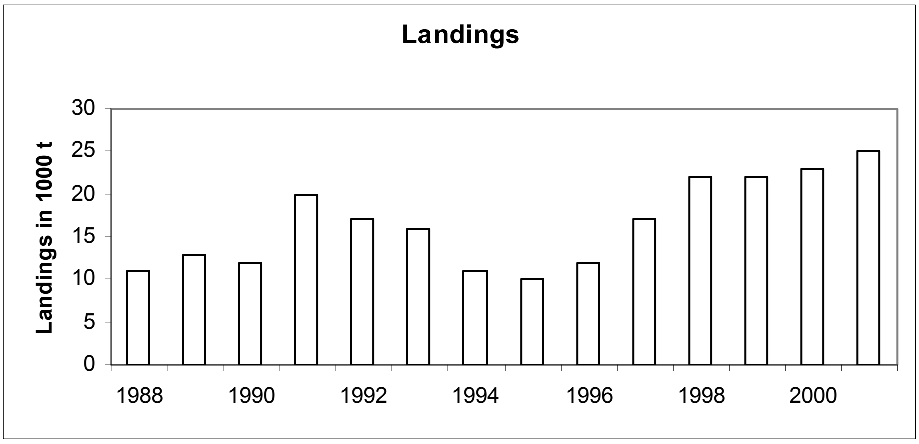


Table 3.13.5.1 Roundnose grenadier (*Coryphaenoides rupestris*). Working Group estimates of landings (tonnes).

Roundnose grenadier in Subarea I and II

Year	Faroe	Denmark	France	Germany	Norway	Russia	GDR	E & W	Scotland	Total
1988	-	-	-	-	-	-	-	-	-	-
1989	-	-	1	2	-	16	3	-	-	22
1990	-	-	32	2	-	12	3	-	-	49
1991	-	-	41	3	28	-	-	-	-	72
1992	-	1	22	0	29	-	-	-	-	52
1993	-	-	13	0	2	-	-	-	-	15
1994	-	-	3	12	-	-	-	-	-	15
1995	-	-	7	-	-	-	-	-	-	7
1996	-	-	2	-	-	-	-	-	-	2
1997	1	-	5	-	100	-	-	-	-	106
1998	-	-	0	-	87	13	-	-	-	100
1999	-	-	0	-	44	2	-	-	-	46
2000	-	-	0	-	-	-	-	-	0	0
2001*	-	-	0	-	-	-	-	2	0	2

* Preliminary.

Roundnose grenadier in Subarea III

Year	Denmark	Norway	Sweden	Total
1988	612	-	5	617
1989	884	-	1	885
1990	785	280	2	1,067
1991	1,214	304	10	1,528
1992	1,362	211	755	2,328
1993	1,103	55	-	1,158
1994	517	-	42	559
1995	0	-	1	1
1996	2,213	-	-	2,213
1997	0	124	42	166
1998	1,490	329	-	1,819
1999	3,113	13	-	3,126
2000	2,400	4	-	2,404
2001*	3,067	35	-	3,102

* Preliminary.

Roundnose grenadier in Subarea IV

Year	France	Germany	Norway	Scotland	Denmark	Total
1988	-	1	-	-	-	1
1989	167	1	-	2	-	170
1990	370	2	-	-	-	372
1991	521	4	-	-	-	525
1992	421	-	-	4	1	426
1993	279	4	-	-	0	283
1994	185	2	-	-	25	212
1995	68	1	-	15	0	84
1996	59	-	-	5	7	71
1997	1	-	-	10	0	11
1998	35	-	0	-	0	35
1999	56	-	5	-	0	61
2000	2	-	-	-	0	2
2001*	2	-	-	-	17	19

* Preliminary.

Continued …

Table 3.13.5.1 Continued

Roundnose grenadier in Division Va

Year	Faroes	Iceland [1]	Germany	E & W	Total
1988	-	2	-	-	2
1989	2	2	-	-	4
1990	-	7	-	-	7
1991	-	48	-	-	48
1992	-	210	-	-	210
1993	-	276	-	-	276
1994	-	210	-	-	210
1995	0	398	-	-	398
1996	1	139	-	-	140
1997	0	198	-	-	198
1998	-	120	0	-	120
1999	-	129	0	-	129
2000	-	67	-	-	67
2001*	-	57	-	0	57

* Preliminary. (1) Includes other grenadiers from 1988 to 1996.

Roundnose grenadier in Division Vb

Year	Faroes	France	Norway	Germany	Russia	U.K.	Total
1988	-	-	-	1	-	-	1
1989	20	181	-	5	52	-	258
1990	75	1,470	-	4	-	-	1,549
1991	22	2,281	7	1	-	-	2,311
1992	551	3,259	1	6	-	-	3,817
1993	339	1,328	-	14	-	-	1,681
1994	286	381	-	1	-	-	668
1995	405	818	-	-	-	-	1,223
1996	93	983	-	2	-	-	1,078
1997	53	1,059	-	-	-	-	1,112
1998	50	1,617	-	-	-	-	1,667
1999	104	1,861	2	0	-	29	1,996
2000	44	1,699	-	1	1	43	1,788
2001*	-	1,719	-	-	-	-	1,719

* Preliminary.

Roundnose grenadier in Subarea VI

Year	Faroes	France	Germany	Ireland	Norway	Spain	E & W	Scotland	Russia	Total
1988	27	-	4	-	-	-	1	-		32
1989	2	2,211	3	-	-	-	-	2		2,218
1990	29	5,484	2	-	-	-	-	-	-	5,515
1991	-	7,297	7	-	-	-	-	-	-	7,304
1992	99	6,422	142	-	5	-	2	112	-	6,782
1993	263	7,940	1	-	-	-	-	1	-	8,205
1994	-	5,898	15	14	-	-	-	11	-	5,938
1995	0	6,329	2	59	-	-	-	82	-	6,472
1996	0	5,888	-	-	-	-	-	156	-	6,044
1997	15	5,795	-	4	-	-	-	218	-	6,032
1998	13	5,170	-	-	21	3	-	-	-	5,207
1999	-	5,637	3	1	-	1	-	-	-	5,642
2000	-	7,423	-	41	1	1,002	1	433	-	8,901
2001*	-	5,587	6	31	32	2,166	21	955	3	8,801

* Preliminary.

Continued …

Table 3.13.5.1 Continued

Roundnose grenadier in Subarea VII

Year	France	Ireland	Spain	Total
1988	-	-	-	0
1989	222	-	-	222
1990	215	-	-	215
1991	489	-	-	489
1992	1,556	-	-	1,556
1993	1,916	-	-	1,916
1994	1,922	-	-	1,922
1995	1,295	-	-	1,295
1996	1,051	-	-	1,051
1997	1,033	-	5	1,038
1998	1,146	-	11	1,157
1999	892	-	4	896
2000	889	-	0	889
2001*	914	416	0	1,330

* Preliminary

Roundnose grenadier in Subareas VIII and IX

Year	France	Spain	Total
1988	-	-	0
1989	0	-	0
1990	5	-	5
1991	1	-	1
1992	12	-	12
1993	18	-	18
1994	5	-	5
1995	0	-	0
1996	1	-	1
1997	0	0	0
1998	1	19	20
1999	9	7	16
2000	4	5	9
2001*	7	3	10

* Preliminary.

Roundnose grenadier in Subarea X

Year	Faroes	France	E & W	Total
1988	-	-	-	-
1989	-	-	-	0
1990	-	-	-	0
1991	-	-	-	0
1992	-	-	-	0
1993	-	-	-	0
1994	-	-	-	0
1995	0	-	-	0
1996	3	-	-	3
1997	1	-	-	1
1998	1	-	-	1
1999	3	3		6
2000	0	0	74	74
2001*	0	-	-	0

* Preliminary. Continued …

Table 3.13.5.1 Continued

Roundnose grenadier in Subarea XII

Year	Faroes	France	Germ.	Iceland	Ireland	Latvia	Russia	Poland	Spain	E & W	Scot.	Norway	Total
1988	-	-	-	-	-	-	10,600	-	-	-	-	-	10,600
1989	-	0	-	-	-	-	9,500	-	-	-	-	-	9,500
1990	-	0	-	-	-	-	2,800	-	-	-	-	-	2,800
1991	-	14	-	-	-	4,296	3,200	-	-	-	-	-	7,510
1992	-	13	-	-	-	1,684	300	-	-	-	-	-	1,997
1993	-	26	39	-	-	2,176	500	-	-	-	-	-	2,741
1994	457	20	9	-	-	675	-	-	-	-	-	-	1,161
1995	359(1)	285	-	-	-	-	-	-	-	-	-	-	644
1996	136	179	-	77	-	-	200	-	1,136	-	-	-	1,728
1997	138	111	-	-	-	-	700	5,867	1,800	-	-	-	8,676
1998	19	116	-	-	-	-	800	6,769	4,262	-	-	-	11,978
1999	-	287	-	-	-	-(2)	576	546	8,251	-	-	-	9,660
2000	-	391	-	-	-	-	2,325	-	5,791	9	6	-	8,522
2001*	-	156	-	-	3	-	1,714	-	7,670	-	7	1	9,551

* Preliminary. (1) Includes some from VIb. (2) Provisional, indication of important catches from Latvia in 1999, without official report.

Roundnose grenadier in Subarea XIV

Year	Faroes	Germany	Greenland	Iceland (1)	Norway	E & W	Scotland	Russia	Total
1988	-	45	7	-	-	-	-	-	52
1989	3	42	-	-	-	-	-	-	45
1990	-	45	1	-	-	1	-	-	47
1991	-	23	4	-	-	2	-	-	29
1992	-	19	1	4	6	-	1	-	31
1993	-	4	18	4	-	-	-	-	26
1994	-	10	5	-	-	-	-	-	15
1995	0	13	14	-	-	-	-	-	27
1996	0	6	19	-	-	-	-	-	25
1997	6	34	12	-	7	-	-	-	59
1998	1	116	3	-	6	-	-	-	126
1999	-	105	0	-	19	-	-	-	124
2000	-	41	-	-	5	-	-	-	46
2001*	-	11	-	-	7	2	-	72	92

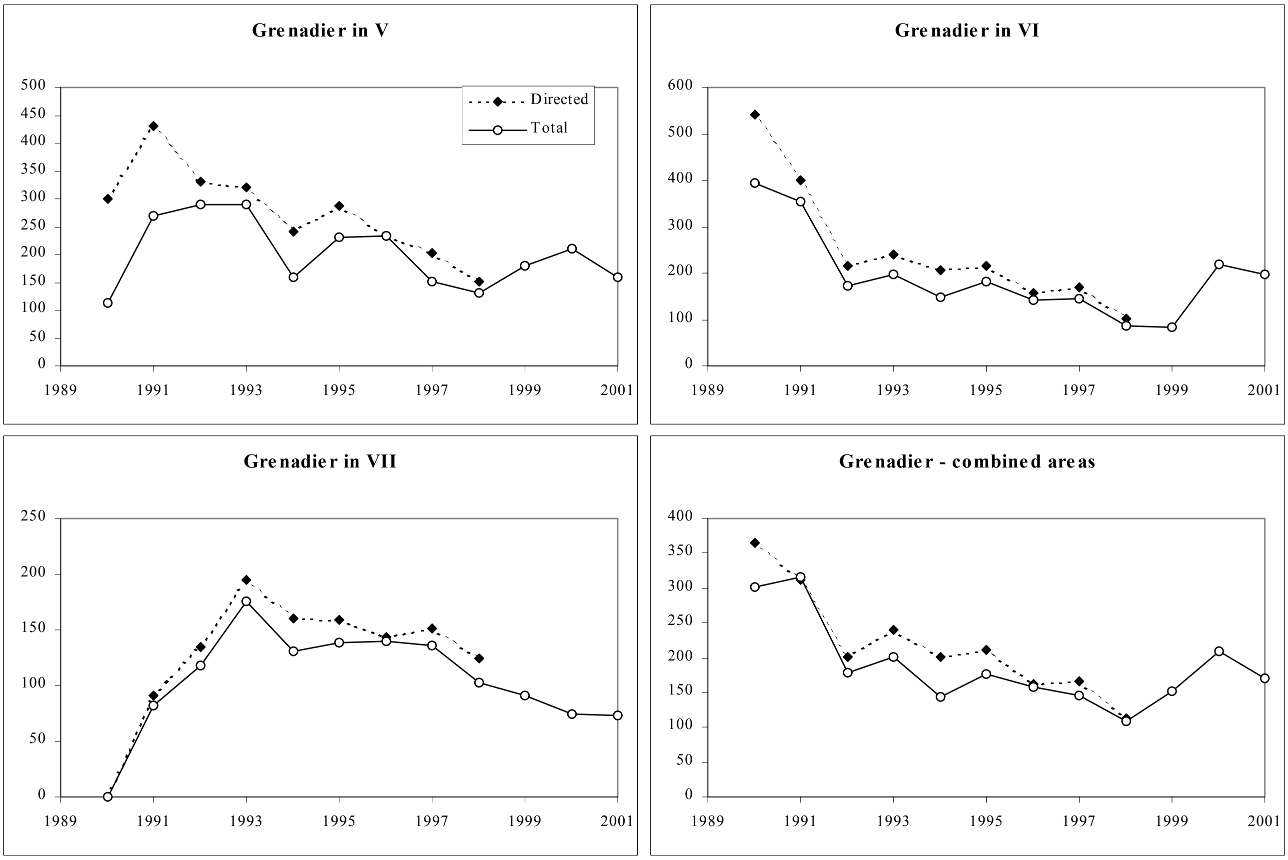
* Preliminary. (1) Includes other grenadiers. Continued …

Table 3.13.5.1 Continued

ROUNDNOSE GRENADIER - Total landings by area/division and grand total

Year	I & II	III	IV	Va	Vb	VI	VII	VIII & IX	X	XII	XIV	**Total**
1988	-	617	1	2	1	32	0	0		10,600	52	**11,305**
1989	22	885	170	4	258	2,218	222	0	0	9,500	45	**13,324**
1990	49	1,067	372	7	1,549	5,515	215	5	0	2,800	47	**11,626**
1991	72	1,528	525	48	2,311	7,304	489	1	0	7,510	29	**19,817**
1992	52	2,328	426	210	3,817	6,782	1,556	12	0	1,997	31	**17,211**
1993	15	1,158	283	276	1,681	8,205	1,916	18	0	2,741	26	**16,319**
1994	15	559	212	210	668	5,938	1,922	5	0	1,161	15	**10,705**
1995	7	1	84	398	1,223	6,472	1,295	0	0	644	27	**10,151**
1996	2	2,213	71	140	1,078	6,044	1,051	1	3	1,728	25	**12,356**
1997	106	166	11	198	1,112	6,032	1,038	0	1	8,676	59	**17,399**
1998	100	1,819	35	120	1,667	5,207	1,157	20	1	11,978	126	**22,230**
1999	46	3,126	61	129	1,996	5,642	896	16	6	9,660	124	**21,702**
2000	0	2,404	2	67	1,788	8,901	889	9	74	8,522	46	**22,702**
2001*	2	3,102	19	57	1,719	8,801	1,330	10	0	9,551	92	**24,683**

* Preliminary.



French trawler CPUE, comparisons using directed and total effort

3.13.6 Black scabbardfish (*Aphanopus carbo*)

State of the stock/exploitation: The stock structure of this species is still unknown. CPUE trends differ between the northern Subareas V, VI, VII, and XII and Subareas VIII and IX. In the northern areas trawl CPUE shows a consistent decline to a historically low level in 1999, a slight increase in 2000, and then a very considerable increase in 2001. While it is possible that this increase reflects some improvement in stock status, it is unlikely that the magnitude of the increase between 2000 and 2001 reflects a corresponding increase in stock abundance. CPUE data from the longliners in Division IXa suggest that the abundance in the southern area has remained relatively stable during the past decade, but the fishery has expanded its area of operation and this could be contributing to maintaining the catch rates.

Advice on management: ICES recommends a significant reduction in the fishing effort in the northern areas. The contradicting trends of the CPUE series make it difficult to advise on the need for effort reduction in the southern area, but certainly no expansion of the effort should be allowed and fisheries should not be allowed to expand until reliable assessments indicate that increased harvests are sustainable.

Relevant factors to be considered in management: It should be noted that black scabbardfish is caught in two very different fisheries, in waters off the Mainland of Portugal (Division IXa) and to the west of the British Isles. In the waters off Mainland of Portugal it is taken in a targeted artisanal longline fishery and CPUE data have been relatively stable over the years. To the west of the British Isles it is taken in a mixed species, mainly French trawl fishery along with roundnose grenadier and sharks.

Comparison with previous assessment and advice: No reliable analytical assessment of black scabbardfish was made in 2002.

Elaboration and special comment: Landings in Table 3.13.6.1. French trawl CPUE and longline CPUE data series are presented in Figures 3.13.6.1 and 3.13.6.2, respectively.

The advice of this year is based on fleets whose dynamics do not appear to be the same, and whether these fleets explain the different stock structure remains unknown.

There is detailed information available on the "artisanal" fishery in Subarea IX. CPUE from this fishery is unlikely to reflect stock trends because the fishery is very localised. CPUE data from the more recently developed fishery in the northern areas are presented in Figure 3.13.6.1, but data of the effort exerted and the geographical distribution of effort over time are missing. Therefore, its validity as a stock indicator is also unknown. In addition, time-series of the size distribution of landings would be very useful.

Source of information: Report of the Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources, 4–10 April 2002 (ICES CM 2002/ACFM:16).

Catch data (Table 3.13.6.1):

Year	ACFM catch
1988	3
1989	4
1990	5
1991	7
1992	9
1993	9
1994	8
1995	8
1996	8
1997	7
1998	6
1999	5
2000	7
2001*	8

*Preliminary. Weights in '000 t.

Black scabbardfish *(Aphanopus carbo*)

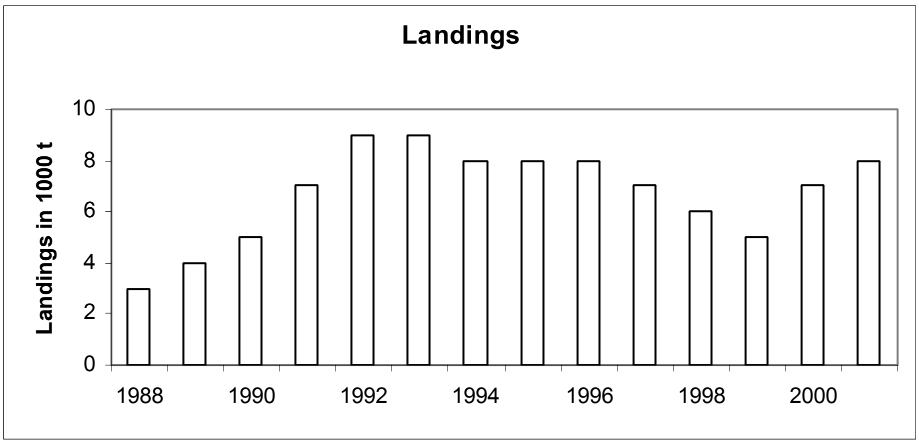


Table 3.13.6.1 Black scabbardfish (*Aphanopus carbo*). Working Group estimates of landings (tonnes).

Black scabbardfish in Subareas III and IV

Year	France	Germany	Scotland	E&W&NI	Total
1988	2	-	-	-	2
1989	0	-	-	-	0
1990	57	-	-	-	57
1991	0	-	-	-	0
1992	0	-	-	-	0
1993	0	-	-	-	0
1994	13	3	-	-	16
1995	-	-	2	-	2
1996	3	-	1	-	4
1997	0	-	2	-	2
1998	-	-	9	-	9
1999	4	-	3	-	6
2000	2	0	3	-	5
2001*	1	0	10	1	12

* Preliminary.

Black scabbardfish in Division Va

Year	Iceland	Total
1988	-	0
1989	-	0
1990	-	0
1991	-	0
1992	-	0
1993	0	0
1994	1	1
1995	+	+
1996	0	0
1997	1	1
1998	0	0
1999	9	9
2000	18	18
2001*	8	8

* Preliminary. Continued …

Table 3.13.6.1 Continued

Black scabbardfish in Division Vb

Year	Faroes	France	Germany	Scotland	E&W&NI	Total
1988	-	-	-	-	-	0
1989	-	166	-	-	-	166
1990	12	407	-	-	-	419
1991	1	151	-	-	-	152
1992	4	29	-	-	-	33
1993	202	76	9	-	-	287
1994	114	45	1	-	-	160
1995	249	175	-	-	-	424
1996	57	129	-	-	-	186
1997	18	50	-	-	-	68
1998	36	144	-	-	-	180
1999	31	135	-	6	-	172
2000	117	186	0	9	-	313
2001*	189	371	0	20	0	581

* Preliminary.

Black scabbardfish in Subareas VI and VII

Year	Faroes	France	Germany	Ireland	Spain	Scotland	E&W&NI	Total
1988								0
1989	46	108						154
1990		1060						1060
1991		2759						2759
1992	3	3433						3436
1993	62	3411	48	8				3529
1994		3050	46	3		2		3101
1995		3257	3			18		3278
1996		3650	2			36	1	3689
1997	3	2754		0	1	235	2	2995
1998		1815		0	3	148	1	1967
1999		1973		1	0	191	1	2166
2000		3235	0	59	1	377	40	3712
2001*		3692	0	68	158	673	34	4625

* Preliminary.

Continued …

Table 3.13.6.1 Continued

Black scabbardfish in Subareas VIII and IX

Year	France	Portugal	Spain	Total
1988	-	2,602	-	2,602
1989	-	3,473	-	3,473
1990	0	3,274	-	3,274
1991	1	3,978	-	3,979
1992	0	4,389	-	4,389
1993	0	4,513	-	4,513
1994	0	3,429	-	3,429
1995	-	4,272	-	4,272
1996	126	3,686	3	3,815
1997	2	3,553	1	3,556
1998	2	3,147	3	3,152
1999	11	2,741	0	2,752
2000	32	2,371	1	2,404
2001*	22	2,744	1	2,767

* Preliminary.

Black scabbardfish in Subarea X

Year	Faroes	Portugal	France	Total
1988	-	-	-	0
1989	-	-	-	0
1990	-	-	-	0
1991	-	166	-	166
1992	370	-	-	370
1993	-	2	-	2
1994	-	-	-	0
1995	-	3	-	3
1996	11	0	-	11
1997	3	0	-	3
1998	31	68	-	99
1999	-	46	66	112
2000	-	112	1	113
2001*	-	0	0	0

* Preliminary.

Continued …

Table 3.13.6.1 Continued

Black scabbardfish in Subarea XII

Year	Faroes	France	Germany	Spain	Scotland	Total
1988	-	-	-	-	-	0
1989	-	-	-	-	-	0
1990	-	-	-	-	-	0
1991	-	-	-	-	-	0
1992	-	512	-	-	-	512
1993	1051	-	93	-	-	1,144
1994	779	-	45	-	-	824
1995	301(1)	-	-	-	-	301
1996	187	4	-	253	-	444
1997	102	-	-	98	-	200
1998	20	-	-	134	-	154
1999	-	3	-	109	0	112
2000	1	6	0	237	-	244
2001	-	3	0	159	-	162

* Preliminary. (1) Includes VIb.

Black scabbardfish in Subarea XIV

Year	Faroes	Spain	Total
1988	-	-	0
1989	-	-	0
1990	-	-	0
1991	-	-	0
1992	-	-	0
1993	-	-	0
1994	-	-	0
1995	-	-	0
1996	-	-	0
1997	-	-	0
1998	2	-	2
1999	-	-	0
2000	-	90	90
2001	-	12	12

* Preliminary.

Continued …

Table 3.13.6.1 Continued

BLACK SCABBARDFISH - Total landings by area/division and grand total

Year	III & IV	Va	Vb	VI & VII	VIII & IX	XII	XIV	Total
1988	2	0	0	0	2,602	0	0	2,604
1989	0	0	166	154	3,473	0	0	3,793
1990	57	0	419	1,060	3,274	0	0	4,810
1991	0	0	152	2,759	3,979	0	0	6,890
1992	0	0	33	3,436	4,389	512	0	8,370
1993	0	0	287	3,529	4,513	1,144	0	9,473
1994	16	1	160	3,101	3,429	824	0	7,531
1995	2	+	424	3,278	4,272	301	0	8,277
1996	4	0	186	3,689	3,815	444	0	8,138
1997	2	1	68	2,995	3,556	200	0	6,822
1998	9	0	180	1,967	3,152	154	2	5,464
1999	6	9	172	2,166	2,752	112	0	5,217
2000	5	18	313	3,712	2,404	244	90	6,786
2001*	12	8	581	4,625	2,767	162	12	8,166

* Preliminary.

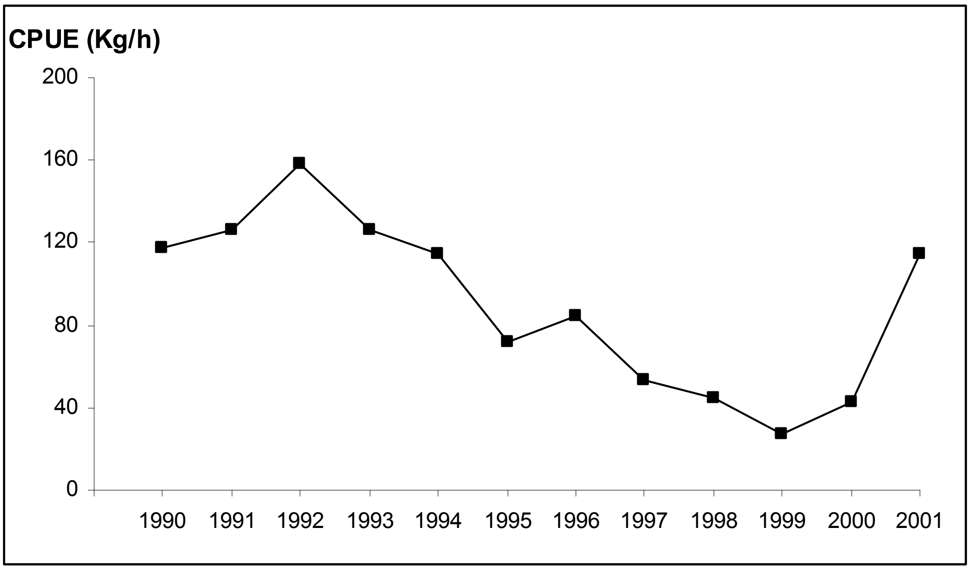


Figure 3.13.6.1 French trawl CPUE data series for combined ICES Subareas V,VI and VII (1990–2001).

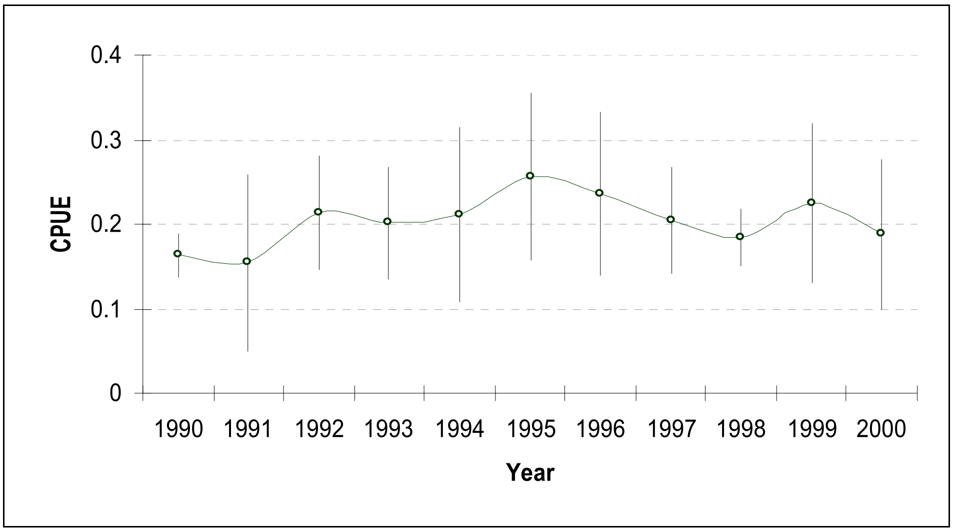


Figure 3.13.6.2 Annual CPUE average estimates from longline fishery in ICES Subarea IXa (1990 and 2000).

3.13.7 Greater silver smelt or argentine (*Argentina silus*)

State of the stock/exploitation: The state of the stock(s) is unknown. Landings have increased considerably in recent years, particularly in Subareas II, VI, and VII.

Advice on management: Greater silver smelt stocks can only sustain very low rates of exploitation. ICES repeats its general recommendation that fisheries on such species, also as by-catch, should only be permitted when they are accompanied by programs to collect data and expand very slowly until reliable assessment indicates that increased harvests are sustainable.

Relevant factors to be considered in management: At least in Subarea VI, the abundance of 20 years and older fish has decreased in recent years, which may suggest high levels of exploitation.

Comparison with previous assessment and advice: No significant changes to the perception of the stock.

Elaboration and special comment: CPUE data may not reflect stock trends, because this is a semi-pelagic shoaling species.

In Subareas I and II the decline in landings in the mid-1990s probably represents a change in target species. In Subareas III and IV the argentine is both targeted and a by-catch fishery. Some preliminary CPUE data are available for Division IIIa but they require further elaboration. In Divisions Va and Vb the fishery has changed from a by-catch to a targeted fishery. The fishery in Subareas VI and VII is on spawning aggregations, but the effort varies according to the availability of other species such as horse mackerel and blue whiting. There has been a marked increase in landings since 1997.

Landings by Subarea/Division and nation are given in Table 3.13.7.1.

Source of information: Report of the Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources, 4–10 April 2002 (ICES CM 2002/ACFM:16)

Catch data (Table 3.13.7.1):

Year	ACFM Catch
1988	25
1989	38
1990	22
1991	16
1992	21
1993	15
1994	16
1995	28
1996	26
1997	26
1998	49
1999	34
2000	36
2001*	45

* Preliminary. Weights in '000 t.

Greater silver smelt or argentine (*Argentina silus*

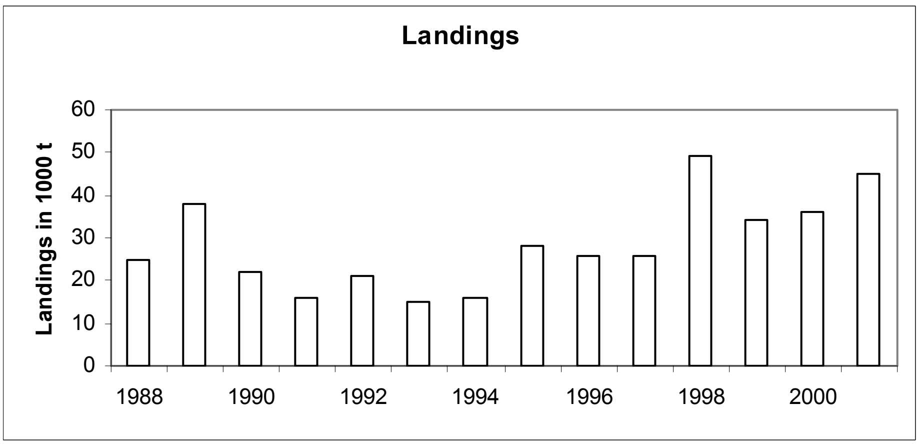


Table 3.13.7.1 Argentines (*Argentina silus)*. Working Group estimates of landings (tonnes).

Argentines in Subareas I and II

Year	Germany	Netherlands	Norway	Poland	Russia	Scotland	France	Total
1988	-	-	11,332	5	14	-	-	11,351
1989	-	-	8,367	-	23	-	-	8,390
1990	-	5	9,115	-	-	-	-	9,120
1991	-	-	7,741	-	-	-	-	7,741
1992	-	-	8,234	-	-	-	-	8,234
1993	-	-	7,913	-	-	-	-	7,913
1994	-	-	6,217	-	-	590	-	6,807
1995	357	-	6,418	-	-	-	-	6,775
1996	-	-	6,604	-	-	-	-	6,604
1997	-	-	4,463	-	-	-	-	4,463
1998	40	-	8,221	-	-	-	-	8,261
1999	-	-	7,145	-	-	18	-	7,163
2000	-	3	6,075	-	195	18	2	6,293
2001*	-	-	14,357	-	7	5	-	14,363

* Preliminary

Argentines in Subareas III and IV

Year	Denmark	Faroes	France	Germany	Netherlands	Norway	Scotland	Sweden	Ireland	Total
1988	1,062	-	-	1	-	1655	-	-	-	2,718
1989	1,322	-	-	-	335	2128	1	-	-	3,786
1990	737	-	-	13	-	1571	-	-	-	2,321
1991	1,421	-	1	-	3	1123	6	-	-	2,554
1992	4,449	-	-	1	70	698	101	-	-	5,319
1993	2,347	-	-	-	298	568	56	-	-	3,269
1994	1,480	-	-	-	-	4	24	-	-	1,508
1995	1,061	-	-	-	-	1	20	-	-	1,082
1996	2,695	370	-	-	-	213	22	-	-	3,300
1997	1,332	-	-	1	-	704	19	542	-	2,598
1998	2,716	-	-	128	277	434	-	427	-	3,982
1999	3,772	-	82	-	6	5	452	-	2	4,319
2000	1,806	-	270	-	-	32	78	273	12	2,471
2001*	1,653	-	28	-	-	3	227	-	3	1,914

* Preliminary.

Continued …

Table 3.13.7.1 Continued

Argentines in Division Va

Year	Iceland	E & W	Total
1988	206	-	206
1989	8	-	8
1990	112	-	112
1991	247	-	247
1992	657	-	657
1993	1,255	-	1,255
1994	613	-	613
1995	492	-	492
1996	808	-	808
1997	3,367	-	3,367
1998	13,387	-	13,387
1999	5,495	23	5,518
2000	4,593	-	4,593
2001*	3,046	-	3,046

* Preliminary.

Argentines in Division Vb

Year	Faroes	Russia	Scotland	E&W&NI	Ireland	France	Total
1988	287	-	-	-	-	-	287
1989	111	116	-	-	-	-	227
1990	2,885	3	-	-	-	-	2,888
1991	59	-	1	-	-	-	60
1992	1,439	4	-	-	-	-	1,443
1993	1,063	-	-	-	-	-	1,063
1994	960	-	-	-	-	-	960
1995	5,534	6,752	-	-	-	-	12,286
1996	9,495	-	3	-	-	-	9,498
1997	8,433	-	-	-	-	-	8,433
1998	17,570	-	-	-	-	-	17,570
1999	8,186	-	15	23	-	5	8,214
2000	7,094	1,185	247	-	-	64	8,343
2001*	9,952	414	94	-	1	-	10,460

* Preliminary.

Continued …

Table 3.13.7.1 Continued

Argentines in Subareas VI and VII

Year	Faroes	France	Germany	Ireland	Neth.	Norway	E & W	Scotland	N.I.	Russia	Spain[1]	Total
1988	-	-	-	5,454	-	4,984	-	-	-	-	-	10,438
1989	188	-	-	6,103	3,715	12,184	198	3,171	-	-	-	25,559
1990	689	-	37	585	5,871	-	-	112	-	-	-	7,294
1991	-	7	-	453	4,723	-	-	10	4	-	-	5,197
1992	-	1	-	320	5,118	-	-	467	-	-	-	5,906
1993	-	-	-	-	1,168	-	-	409	-	-	-	1,577
1994	-	-	43	150	4,137	-	-	1,377	-	-	-	5,707
1995	1,597	-	357	6	5,440	-	-	146	-	-	-	7,546
1996	-	-	1,394	295	3,953	-	-	221	-	-	-	5,863
1997	-	-	1,496	1,089	4,696	-	-	20	-	-	-	7,301
1998	-	-	463	405	4,687	-	-	-	-	-	-	5,555
1999	-	21	24	394	8,025	-	-	387	-	5	-	8,856
2000	-	17	482	4,703	3,633	-	-	4,965	-	29	34	13,863
2001*	-	12	189	7,494	6,882	-	-	7,620	-	76	-	22,273

* Preliminary. [1] Working Group data zero in all years 1997-2001.

Argentines in Subarea XII

Year	Faroes	Iceland	**Total**
1988	-	-	-
1989	-	-	-
1990	-	-	-
1991	-	-	-
1992	-	-	-
1993	6	-	**6**
1994	-	-	-
1995	-	-	-
1996	1	-	**1**
1997	-	-	-
1998	-	-	-
1999	-	-	-
2000	-	2	**2**
2001*	-	-	-

* Preliminary. Continued …

Table 3.13.7.1 Continued

Argentines in Subarea XIV

Year	Norway	Iceland	Total
1988	-	-	-
1989	-	-	-
1990	6	-	6
1991	-	-	-
1992	-	-	-
1993	-	-	-
1994	-	-	-
1995	-	-	-
1996	-	-	-
1997	-	-	-
1998	-	-	-
1999	-	-	-
2000	-	217	217
2001*	66	-	66

* Preliminary.

ARGENTINES - Total landings by area/division and grand total

Year	I & II	III & IV	Va	Vb	VI & VII	XII	XIV	Total
1988	11,351	2,718	206	287	10,438	-	-	25,000
1989	8,390	3,786	8	227	25,559	-	-	37,970
1990	9,120	2,321	112	2,888	7,294	-	6	21,741
1991	7,741	2,554	247	60	5,197	-	-	15,799
1992	8,234	5,319	657	1,443	5,906	-	-	21,559
1993	7,913	3,269	1,255	1,063	1,577	6	-	15,083
1994	6,807	1,508	613	960	5,707	-	-	15,595
1995	6,775	1,082	492	12,286	7,546	-	-	28,181
1996	6,604	3,300	808	9,498	5,863	1	-	26,074
1997	4,463	2,598	3,367	8,433	7,301	-	-	26,162
1998	8,261	3,982	13,387	17,570	5,555	-	-	48,755
1999	7,163	4,319	5,518	8,214	8,856	2	-	34,087
2000	6,293	2,471	4,593	8,343	13,863	-	217	36,027
2001*	14,363	1,914	3,046	10,460	15,391	-	66	45,174

* Preliminary.

3.13.8 Orange roughy (*Hoplostethus atlanticus*)

State of the stock/exploitation: The last analytical assessment for orange roughy in Subarea VI was carried out in 2000. Based on updated CPUE data it is concluded that orange roughy in Subarea VI is outside safe biological limits. The catch has been very low since 1993 and the stock is depleted. The lack of development of this fishery in the most recent years suggests that this stock has not shown any sign of recovery. Moreover, the remaining catches in the area are likely to adversely affect the recovery of the stock. The situation in Subarea VII is highly uncertain. International landings have increased while catch rates have stabilised in recent years, but these features may reflect the sequential discovery and subsequent fishing of previously unexploited aggregations. The state of orange roughy in other areas is unknown. CPUE trends are shown in Figure 3.13.8.1.

Advice on management: Orange roughy stocks cannot sustain high rates of exploitation. Newly-discovered aggregations are often overexploited before enough information is available to provide timely advice on management. Considering recent observations on the fishery developments, the exploitation of orange roughy should be strictly limited and the stocks/populations closely monitored. Data obtained should be incorporated into appropriate management measures. These recommendations should also apply to areas where there is currently no exploitation on orange roughy. There should be no directed fishery in Subarea VI.

Relevant factors to be considered in management: Orange roughy are known to grow to be very old (estimated > 100 years). Another biological characteristic of this species is that it aggregates in local concentrations. Experience in other areas (e.g. South Pacific) has shown that these characteristics make this species especially vulnerable to exploitation. There is concern that the fleets may exploit local aggregations one after the other. Once an aggregation is fished out, these fleets could explore and harvest other concentrations. In that context, the CPUE of such fleets would not reflect the subsequent depletion of the overall stock.

Elaboration and special comment: There are currently four fisheries for orange roughy in the Northeast Atlantic. The main fishery up to 2000 was conducted by French trawlers in Subareas VI and VII. In 2001, an Irish fishery has rapidly developed in Subarea VII, taking the bulk of the landings (2 400 t). The other fisheries include a Faroese fleet, which mainly operates in Division Vb and international waters (Hatton Bank and mid-Atlantic ridge) and a small Icelandic coastal fleet conducted in Division Va. The French fishery in Subarea VI started in 1991 and, after an initial peak of 3 500 t, landings declined rapidly to less than 200 t per annum. French landings in Subarea VII peaked in 1992 at around 3 100 t and in recent years have stabilised at around 1 000 t per annum. The main fishery is on spawning aggregations.

Landings by Subarea/Division and nation are given in Tables 3.13.8.1.

Source of information: Report of the Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources, 4–10 April 2002 (ICES CM 2002/ACFM:16).

Catch data (Table 3.13.8.1):

Year	ACFM Catch
1988	0
1989	+
1990	+
1991	5
1992	5
1993	3
1994	2
1995	2
1996	2
1997	2
1998	2
1999	2
2000	2
2001*	4

*Preliminary. Weights in '000 t.

Orange roughy (*Hoplostethus atlanticus*)

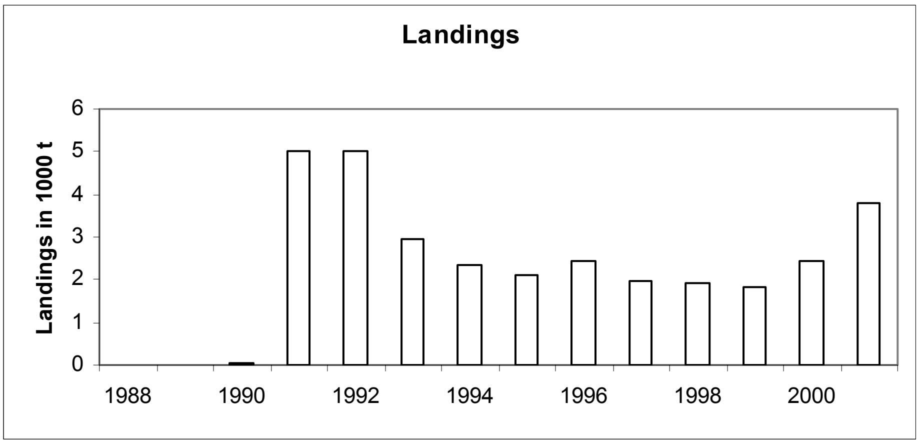


Table 3.13.8.1 Orange roughy (*Hoplostethus atlanticus*). Working Group estimates of landings (tonnes).

Orange roughy in Division Va

Year	Iceland	Total
1988	-	0
1989	-	0
1990	-	0
1991	65	65
1992	382	382
1993	717	717
1994	158	158
1995	64	64
1996	40	40
1997	79	79
1998	28	28
1999	14	14
2000	68	68
2001*	19	19

*Preliminary.

Orange roughy in Division Vb

Year	Faroes	France	Total
1988	-	-	0
1989	-	-	0
1990	-	22	22
1991	-	48	48
1992	1	12	13
1993	36	1	37
1994	170	+	170
1995	419	1	420
1996	77	2	79
1997	17	1	18
1998	-	3	3
1999	4	1	5
2000	155	0	155
2001*	1	4	5

*Preliminary.

Continued …

Table 3.13.8.1 Continued

Orange roughy in Subarea VI

Year	Faroes	France	E & W	Scotland	Ireland	Spain	Total
1988	-	-	-	-	-	-	0
1989	-	5	-	-	-	-	5
1990	-	15	-	-	-	-	15
1991	-	3,502	-	-	-	-	3,502
1992	-	1,422	-	-	-	-	1,422
1993	-	429	-	-	-	-	429
1994	-	179	-	-	-	-	179
1995	40	74	-	2	-	-	116
1996	0	116	-	0	-	-	116
1997	29	116	1	-	-	-	146
1998	-	100	-	-	-	2	102
1999	-	175	-	-	0	1	176
2000	-	136	-	-	2	-	138
2001*	-	159	-	11	110	-	280

* Preliminary.

Orange roughy in Subarea VII

Year	France	Spain	E & W	Ireland	Scotland	Total
1988	-	-	-	-	-	0
1989	3	-	-	-	-	3
1990	2	-	-	-	-	2
1991	1,406	-	-	-	-	1,406
1992	3,101	-	-	-	-	3,101
1993	1,668	-	-	-	-	1,668
1994	1,722	-	-	-	-	1,722
1995	831	-	-	-	-	831
1996	879	-	-	-	-	879
1997	893	-	-	-	-	893
1998	963	6	-	-	-	969
1999	1,157	4	-	-	-	1,161
2000	1,019	-	729	1		1,749
2001*	1,022	-	-	2,367	22	3,411

*Preliminary.

Continued …

Table 3.13.8.1 Continued

Orange roughy in Subarea VIII

Year	France	Spain VIII&IX	E & W	Total
1988	-	-	-	0
1989	0	-	-	0
1990	0	-	-	0
1991	0	-	-	0
1992	83	-	-	83
1993	68	-	-	68
1994	31	-	-	31
1995	7	-	-	7
1996	22	-	-	22
1997	1	22	-	23
1998	4	10	-	14
1999	33	6	-	39
2000	47	-	5	52
2001*	20	-	-	20

*Preliminary.

Orange roughy in Subarea IX

Year	Spain	Total
1988	-	0
1989	-	0
1990	-	0
1991	-	0
1992	-	0
1993	-	0
1994	-	0
1995	-	0
1996	-	0
1997	1	1
1998	1	1
1999	1	1
2000	0	0
2001*	0	0

*Preliminary.

Continued …

Table 3.13.8.1 Continued

Orange roughy in Subarea X

Year	Faroes	France	Norway	E & W	Portugal	Total
1988	-		-	-	-	0
1989	-	-	-	-	-	0
1990	-	-	-	-	-	0
1991	-	-	-	-	-	0
1992	-	-	-	-	-	0
1993	-	-	1	-	-	1
1994	-	-	-	-	-	0
1995	-	-	-	-	-	0
1996	470	1	-	-	-	471
1997	6	-	-	-	-	6
1998	177	-	-	-	-	177
1999	-	10	-	-	-	10
2000	-	3	-	28	157	188
2001*	-	-	-	28	-	28

*Preliminary.

Orange roughy in Subarea XII

Year	Faroes	France	Iceland	Spain	E & W	Total
1988	-	-	-	-	-	0
1989	-	0	-	-	-	0
1990	-	0	-	-	-	0
1991	-	0	-	-	-	0
1992	-	8	-	-	-	8
1993	24	8	-	-	-	32
1994	89	4	-	-	-	93
1995	580	96	-	-	-	676
1996	779	36	3	-	-	818
1997	802	6	-	-	-	808
1998	570	59	-	-	-	629
1999	345	43	-	43	-	431
2000	69	21	-	-	2	92
2001*	-	14	-	-	2	16

*Preliminary.

Continued …

Table3.13.8.1 Continued

ORANGE ROUGHY - Total landings by area/division and grand total

Year	Va	Vb	VI	VII	VIII	X	XII	Total
1988	0	0	0	0	0	0	0	0
1989	0	0	5	3	0	0	0	8
1990	0	22	15	2	0	0	0	39
1991	65	48	3,502	1,406	0	0	0	5,021
1992	382	13	1,422	3,101	83	0	8	5,009
1993	717	37	429	1,668	68	1	32	2,952
1994	158	170	179	1,722	31	0	93	2,353
1995	64	420	116	831	7	0	676	2,114
1996	40	79	116	879	22	471	818	2,425
1997	79	18	146	893	23	6	808	1,973
1998	28	3	102	969	14	177	629	1,922
1999	14	5	176	1,161	39	10	431	1,836
2000	68	155	138	1,749	52	188	92	2,442
2001*	19	5	280	3,411	20	28	16	3,779

*Preliminary.

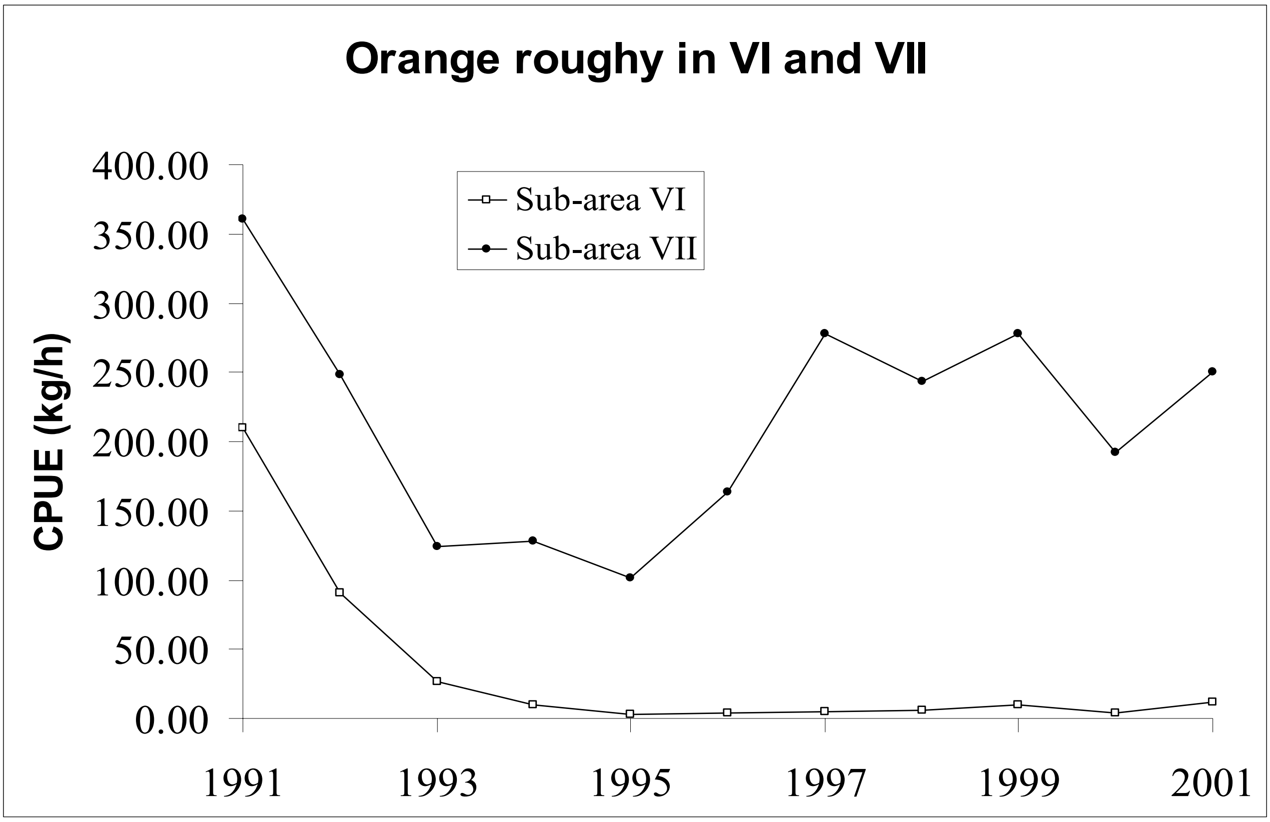


Figure 3.13.8.1 CPUE (kg/h) from the French reference fleet in Subareas VI and VII.

3.13.9 Red (=blackspot) seabream (*Pagellus bogaraveo*)

State of the stock/exploitation: The state of the stock in Subareas X and IX is unknown and in other areas (VI, VII, and VIII) seems to be severely depleted judging from comparisons between current and historical landings data, which indicate that the fishery started in the 1970s with a CPUE of 20-24 000 t/year, while since the late 1980s the CPUE has been in the range of 1-2 000 t/year.

Advice on management: Red seabream stocks can only sustain very low rates of exploitation. ICES repeats its general recommendation that fisheries on such species be permitted only when they are accompanied by programs to collect data and expand very slowly until reliable assessments indicate that increased harvests are sustainable.

Comparison with previous assessment and advice: The perception of the state of the stock has not changed significantly since last year.

Elaboration and special comment: There is a directed handline and longline fishery in Subareas IX and X. Red seabream appears as by-catch in the longline and trawl fishery on hake, megrim, angler, and *Nephrops* in Subareas VI, VII, and VIII.

Landings by Subarea/Division and nation are given in Table 3.13.9.1.

Source of information: Report of the Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources, 4–10 April 2002 (ICES CM 2002/ACFM:16).

Catch data (Table 3.13.9.1)

Year	ACFM Catch
1988	1,715
1989	2,061
1990	1,929
1991	1,663
1992	2,071
1993	2,026
1994	2,203
1995	2,046
1996	2,066
1997	2,104
1998	2,112
1999	1,884
2000	1,655
2001*	1,629

*Preliminary. Weights in t.

Red (=blackspot) seabream (*Pagellus bogaraveo*

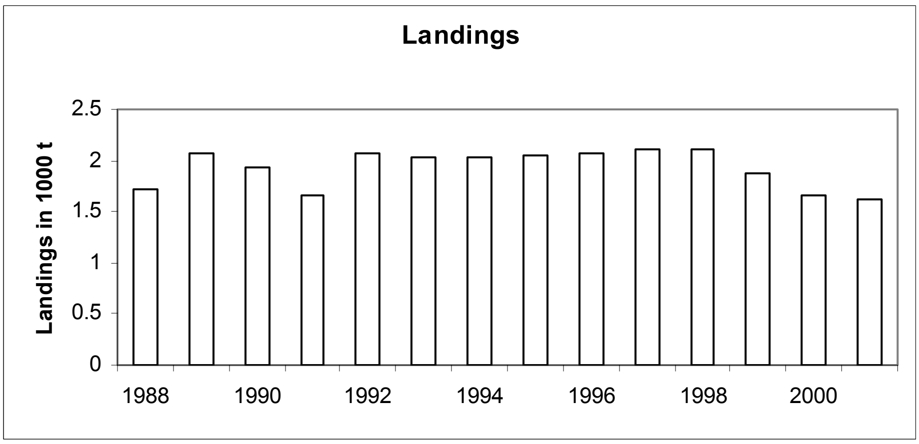


Table 3.13.9.1 Red (=blackspot) seabream (*Pagellus bogaraveo*): Working Group estimates of landings (tonnes).

Red (=blackspot) seabream in Subareas VI and VII

Year	France	Ireland	Spain	E & W	Ch. Islands	Total
1988	52	0	47	153	0	252
1989	44	0	69	76	0	189
1990	22	3	73	36	0	134
1991	13	10	30	56	14	123
1992	6	16	18	0	0	40
1993	5	7	10	0	0	22
1994	0	0	9	0	1	10
1995	0	6	5	0	0	11
1996	0	4	24	1	0	29
1997	0	20	0	36	-	56
1998	0	4	7	6	-	17
1999	0	8	0	15	-	25
2000	4	n/a	3	13	-	20
2001*	1	11	1	37	-	50

* Preliminary.

Red (=blackspot) seabream in Subarea VIII

Year	France	Spain	England	Total
1988	37	91	9	137
1989	31	234	7	272
1990	15	280	17	312
1991	10	124	0	134
1992	5	119	0	124
1993	3	172	0	175
1994	0	131	0	131
1995	0	110	0	110
1996	0	23	0	23
1997	18	7	0	25
1998	18	86	0	104
1999	20	84	0	104
2000	81	187	0	268
2001*	11	159	0	170

* Preliminary.

Red (=blackspot) seabream in Subarea IX

Year	Portugal	Spain	Total
1988	370	319	689
1989	260	416	676
1990	166	428	594
1991	109	423	532
1992	166	631	797
1993	235	765	1,000
1994	150	854	1,004
1995	204	625	829
1996	209	769	978
1997	203	808	1,011
1998	357	520	877
1999	265	278	543
2000	83	338	421
2001*	97	278	375

* Preliminary. Continued …

Table 3.13.9.1 Continued

Red (=blackspot) seabream in Subarea X

Year	Portugal	Total
1988	637	637
1989	924	924
1990	889	889
1991	874	874
1992	1,110	1,110
1993	829	829
1994	983	983
1995	1,096	1,096
1996	1,036	1,036
1997	1,012	1,012
1998	1,114	1,114
1999	1,222	1,222
2000	947	947
2001*	1,034	1,034

*Preliminary.

Red (=blackspot) seabream in Subarea XII

Year	Latvia	Total
1988	-	0
1989	-	0
1990	-	0
1991	-	0
1992	-	0
1993	-	0
1994	75	75
1995	-	0
1996	-	0
1997	-	0
1998	-	0
1999	-	0
2000	-	0
2001*	-	0

* Preliminary.

Red (=blackspot) seabream in Madeira (Portugal)

Year	Portugal	Total
1988		0
1989		0
1990	6	6
1991	8	8
1992	7	7
1993	8	8
1994	7	7
1995	8	8
1996	4	4
1997	5	5
1998	14	14
1999	13	13
2000		
2001*		

*Preliminary. Continued …

Table 3.13.9.1 Continued

RED (=BLACKSPOT) SEABREAM in ICES Subareas

Year	VI &VII	VIII	IX	X	XII	Total
1988	252	137	689	637	0	1,715
1989	189	272	676	924	0	2,061
1990	134	312	594	889	0	1,929
1991	123	134	532	874	0	1,663
1992	40	124	797	1,110	0	2,071
1993	22	175	1,000	829	0	2,026
1994	10	131	1,004	983	75	2,203
1995	11	110	829	1,096	0	2,046
1996	29	23	978	1,036	0	2,066
1997	56	25	1,011	1,012	0	2,104
1998	17	104	877	1,114	0	2,112
1999	25	104	543	1,222	0	1,884
2000	20	268	421	947	0	1,655
2001*	50	170	275	1,034	0	1,629

* Preliminary.

3.13.10 Greater forkbeard (*Phycis blennoides*)

State of the stock/exploitation: The state of the stocks in the various ICES Subareas where this species occurs is unknown.

Advice on management: Greater forkbeard stocks can probably only sustain very low rates of exploitation. ICES repeats its general recommendation that fisheries on such species, also as by-catch, should be permitted only when they are accompanied by programs to collect data and expand very slowly until reliable assessments indicate that increased harvests are sustainable.

Relevant factors to be considered in management: The general character of the fishery for this species makes the fishery difficult to manage in a single-species context.

Comparison with previous assessment and advice: The perception of the state of the stock has not changed significantly since last year.

Catch data (Table 3.13.10.1)

Year	ACFM Catch
1988	2,025
1989	2,015
1990	2,381
1991	2,045
1992	2,128
1993	2,035
1994	2,045
1995	2,609
1996	4,118
1997	2,742
1998	3,764
1999	3,913
2000	5,092
2001*	4,790

*Preliminary. Weights in t.

Elaboration and special comment: The landings of greater forkbeard are mainly by-catch from both trawl and longline fisheries. Subareas VI and VII comprise around 85% of the species' total landings in ICES area. Fluctuations in landings are probably the result of changing effort on different target species and/or market prices. The increase in landings in Subareas VIII and IX probably stems from a directed longline fishery.

Landings by Subarea/Division and nation are given in Table 3.13.10.1.

Source of information: Report of the Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources, 4 – 10 April 2002 (ICES CM 2002/ACFM:16).

Greater forkbeard (*Phycis blennoides*)

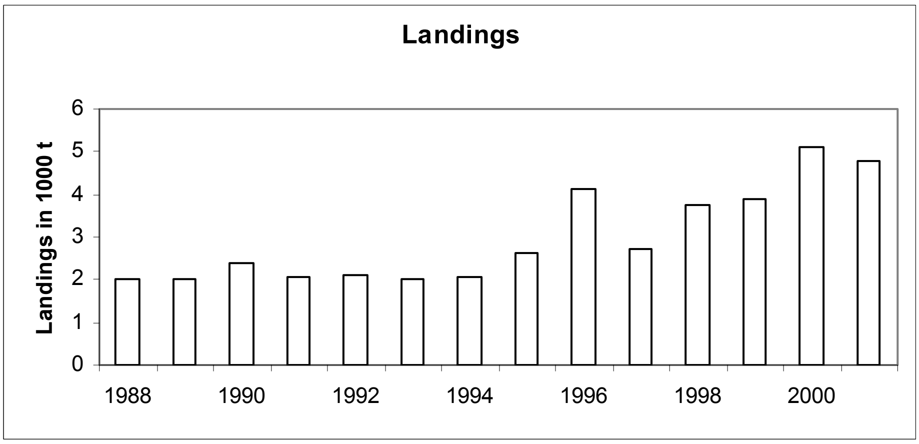


Table 3.13.10.1 Greater forkbeard (*Phycis blennoides*). Working Group estimates of landings (tonnes).

Greater forkbeard in Subareas I and II

Year	Norway	France	Russia	Total
1988	0	-	-	0
1989	0	-	-	0
1990	23	-	-	23
1991	39	-	-	39
1992	33	-	-	33
1993	1	-	-	1
1994	0	-	-	0
1995	0	-	-	0
1996	0	-	-	0
1997	0	-	-	0
1998	0	-	-	0
1999	0	0	-	0
2000	0	0	-	0
2001*	0	1	7	8

*Preliminary.

Greater forkbeard in Subareas III and IV

Year	France	Norway	E&W&NI	Scotland (1)	Germany	Total
1988	12	0	3	0	-	15
1989	12	0	0	0	-	12
1990	18	92	5	0	-	115
1991	20	161	0	0	-	181
1992	13	130	0	2	-	145
1993	6	28	0	0	-	34
1994	11	-	-	1	-	12
1995	2	-	-	1	-	3
1996	2	10	-	6	-	18
1997	2	-	-	5	-	7
1998	1	-	0	11	-	12
1999	3	-	5	23	-	31
2000	3	-	0	7	-	11
2001*	5	-	1	19	2	26

*Preliminary.
(1) Includes Moridae.

Greater forkbeard in Division Vb

Year	France	Norway	E&W&NI	Scotland (1)	Total
1988	2	0	-	-	2
1989	1	0	-	-	1
1990	10	28	-	-	38
1991	9	44	-	-	53
1992	16	33	-	-	49
1993	5	22	-	-	27
1994	4	-	-	-	4
1995	9	-	-	-	9
1996	7	-	-	-	7
1997	7	-	-	-	7
1998	4	4	-	-	8
1999	6	28	-	0	34
2000	4	26	0	1	32
2001*	5	92	-	1	98

*Preliminary.
Continued …
(1) Includes Moridae.

Table 3.13.10.1 Continued

Greater forkbeard in Subareas VI and VII

Year	France	Ireland	Norway	Spain	E&W&NI	Scotland [1]	Germany	Russia	Total
1988	252	0	0	1,584	62	0	-	-	1,898
1989	342	14	0	1,446	13	0	-	-	1,815
1990	454	0	88	1,372	6	1	-	-	1,921
1991	476	1	126	953	13	5	-	-	1,574
1992	646	4	244	745	0	1	-	-	1,640
1993	582	0	53	824	0	3	-	-	1,462
1994	451	111	-	1,002	0	7	-	-	1,571
1995	430	163	-	722	808	15	-	-	2,138
1996	519	154	-	1,428	1,434	55	-	-	3,590
1997	512	131	5	46	1,460	181	-	-	2,335
1998	357	530	162	530	1,364	97	-	-	3,040
1999	317	686	183	796	929	518	1	-	3,430
2000	622	743	380	1,263	731	820	8	2	4,568
2001*	587	663	536	1,138	538	640	10	4	4,116

*Preliminary.
[1] Includes Moridae.

Greater forkbeard in Subareas VIII and IX

Year	France	Portugal	Spain	Total
1988	7	0	74	81
1989	7	0	138	145
1990	16	0	218	234
1991	18	4	108	130
1992	9	8	162	179
1993	0	8	387	395
1994	-	0	320	320
1995	54	0	330	384
1996	25	2	429	456
1997	4	1	356	361
1998	3	6	656	665
1999	6	10	361	377
2000	31	6	346	383
2001*	22	8	421	451

*Preliminary.

Greater forkbeard in Subarea X

Year	Portugal [1]	Total
1988	29	29
1989	42	42
1990	50	50
1991	68	68
1992	81	81
1993	115	115
1994	135	135
1995	71	71
1996	45	45
1997	30	30
1998	38	38
1999	41	41
2000	94	94
2001*	83	83

*Preliminary. Continued …
[1] Includes Moridae.

Table 3.13.10.1 Continued

Greater forkbeard in Subarea XII

Year	France	Norway	E&W&NI	Scotland [1]	Total
1988	-	-	-	-	-
1989	-	-	-	-	-
1990	-	-	-	-	-
1991	-	-	-	-	-
1992	1	-	-	-	1
1993	1	-	-	-	1
1994	3	-	-	-	3
1995	4	-	-	-	4
1996	2	-	-	-	2
1997	2	-	-	-	2
1998	1	-	-	-	1
1999	0	-	-	0	0
2000	2	-	-	4	6
2001*	0	6	1	1	8

*Preliminary.
(1) Includes Moridae.

Greater forkbeard in ICES Subareas

Year	I & II	III & IV	Vb	VI & VII	VIII & IX	X	XII	Total
1988	0	15	2	1,898	81	29	0	2,025
1989	0	12	1	1,815	145	42	0	2,015
1990	23	115	38	1,921	234	50	0	2,381
1991	39	181	53	1,574	130	68	0	2,045
1992	33	145	49	1,640	179	81	1	2,128
1993	1	34	27	1,462	395	115	1	2,035
1994	0	12	4	1,571	320	135	3	2,045
1995	0	3	9	2,138	384	71	4	2,609
1996	0	18	7	3,590	456	45	2	4,118
1997	0	7	7	2,335	361	30	2	2,742
1998	0	12	8	3,040	665	38	1	3,764
1999	0	31	34	3,430	377	41	0	3,913
2000	0	11	32	4,568	383	94	6	5,092
2001*	8	26	98	4,116	451	83	8	4,790

*Preliminary.

3.13.11 Alfonsinos/Golden eye perch (*Beryx* spp.)

State of the stock/exploitation: The state of the stocks in the various Subareas where these species occur is unknown.

Advice on management: According to the spatial distribution of the species and their aggregating behaviour alfonsinos are very susceptible to exploitation. ICES repeats its general recommendation that fisheries on such species be permitted only when they are accompanied by programs to collect data and expand very slowly until reliable assessments indicate that increased harvests are sustainable.

Relevant factors to be considered in management: Management of these species must take into account their limited spatial scale of distribution on seamounts, and the uncontrolled fishing activities in international waters.

Catch data (Table 3.13.11.1)

Year	ACFM Catch
1988	225
1989	272
1990	353
1991	371
1992	460
1993	729
1994	1,507
1995	711
1996	802
1997	1,143
1998	578
1999	460
2000	489
2001*	526

*Preliminary. Weights in t.

Comparison with previous assessment and advice: The perception of the state of the stock has not changed significantly since last year.

Elaboration and special comment: In most cases the landings refer to both species combined (*Beryx splendens* and *B. decadactylus*). Most of the landings of *Beryx* are from handlines and longlines within the Azorean EEZ of Subarea X and by trawl outside the EEZ on the Mid-Atlantic Ridge.

In various seamounts of the Subarea X there are some indications that the stocks were intensely exploited during the last decade.

Landings by Subarea/Division and nation are given in Table 3.13.11.1.

Source of information: Report of the Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources, 4–10 April 2002 (ICES CM 2002/ACFM:16).

Alfonsinos/Golden eye perch (Beryx spp.)

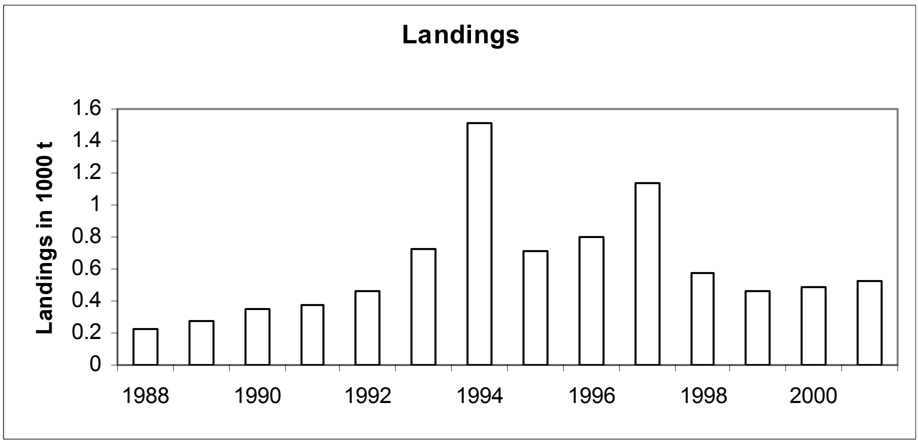


Table 3.13.11.1 Alfonsinos/Golden eye perch (*Beryx* spp). Working Group estimates of landings (tonnes).

Alfonsinos in Subarea IV

Year	France	**Total**
1988	0	**0**
1989	0	**0**
1990	1	**1**
1991	0	**0**
1992	2	**2**
1993	0	**0**
1994	0	**0**
1995	0	**0**
1996	0	**0**
1997	0	**0**
1998	0	**0**
1999	0	**0**
2000	0	**0**
2001*	0	**0**

* Preliminary.

Alfonsinos in Division Vb

Year	Faroes	France	**Total**
1988	-	-	**0**
1989	-	-	**0**
1990	-	5	**5**
1991	-	0	**0**
1992	-	4	**4**
1993	-	0	**0**
1994	-	0	**0**
1995	1	0	**1**
1996	0	0	**0**
1997	0	0	**0**
1998	0	0	**0**
1999	0	0	**0**
2000	0	0	**0**
2001*	0	0	**0**

* Preliminary.

Continued …

Table 3.13.11.1 Continued

Alfonsinos in Subareas VI and VII

Year	France	E & W	Spain	**Total**
1988	-	-	-	-
1989	12	-	-	**12**
1990	8	-	-	**8**
1991	-	-	-	**0**
1992	3	-	-	**3**
1993	0	-	1	**1**
1994	0	-	5	**5**
1995	0	-	3	**3**
1996	0	-	178	**178**
1997	17	4	4	**25**
1998	10	0	71	**81**
1999	67	0	20	**87**
2000	-	2	98	**100**
2001*	-	-	103	**103**

* Preliminary.

Alfonsinos in Subareas VIII and IX

Year	France	Portugal	Spain	E & W	**Total**
1988	-	-	-	-	-
1989	-	-	-	-	-
1990	1	-	-	-	**1**
1991	-	-	-	-	**0**
1992	1	-	-	-	**1**
1993	0	-	-	-	**0**
1994	0	-	2	-	**2**
1995	0	75	7	-	**82**
1996	0	43	45	-	**88**
1997	69	35	31	-	**135**
1998	1	9	259	-	**269**
1999	8	29	161	-	**198**
2000	-	40	116	4	**160**
2001*	-	43	181	-	**224**

* Preliminary.

Continued …

Table 3.13.11.1 Continued

Alfonsinos in Subarea X

Year	Faroes	Norway	Portugal	Russia	E & W	**Total**
1988			225			**225**
1989			260			**260**
1990			338			**338**
1991			371			**371**
1992			450			**450**
1993		195	533			**728**
1994		0	636	864		**1,500**
1995	0	0	523	100		**623**
1996	0		536			**536**
1997	5		378	600		**983**
1998	0		228			**228**
1999	0		175			**175**
2000			209	5	15	**229**
2001*			199			**199**

* Preliminary.

Alfonsinos in Subarea XII

Year	Faroes	**Total**
1988	-	**0**
1989	-	**0**
1990	-	**0**
1991	-	**0**
1992	-	**0**
1993	-	**0**
1994	-	**0**
1995	2	**2**
1996	0	**0**
1997	0	**0**
1998	0	**0**
1999	0	**0**
2000	0	**0**
2001*	0	**0**

* Preliminary. Continued …

Table 3.13.11.1 Continued

Alfonsinos in Madeira (Portugal)

Year	Portugal	**Total**
1988	-	**0**
1989	-	**0**
1990	-	**0**
1991	-	**0**
1992	-	**0**
1993	-	**0**
1994	-	**0**
1995	1	**1**
1996	11	**11**
1997	4	**4**
1998	3	**3**
1999	2	**2**
2000	-	**0**
2001*	-	**0**

* Preliminary.

Alfonsinos in ICES Subareas

Year	IV	Vb	VI & VII	VIII & IX	X	XII	**Total**
1988	0	0	0	0	225	0	**225**
1989	0	0	12	0	260	0	**272**
1990	1	5	8	1	338	0	**353**
1991	0	0	0	0	371	0	**371**
1992	2	4	3	1	450	0	**460**
1993	0	0	1	0	728	0	**729**
1994	0	0	5	2	1,500	0	**1,507**
1995	0	1	3	82	623	2	**711**
1996	0	0	178	88	536	0	**802**
1997	0	0	25	135	983	0	**1,143**
1998	0	0	81	269	228	0	**578**
1999	0	0	87	198	175	0	**460**
2000	0	0	100	160	229	0	**489**
2001*	0	0	103	224	199	0	**526**

* Preliminary.

3.13.12 Deepwater sharks

State of the stock/exploitation: The state of these species is unknown. Mixed species CPUE are declining, which is consistent with decreasing abundance of the complex of deepwater shark species as a whole, and particularly with a deteriorating state of species preferred or most vulnerable when the deepwater fisheries for sharks expanded/commenced.

Some amounts of deepwater sharks are reported together with other sharks under the heading "various sharks". It is not possible to identify which proportion of these are deepwater sharks and the statistics provided in Table 3.13.12.1 do not include any account of these sharks. Therefore, Table 3.13.12.1 provides an underestimate of the catch of deepwater sharks.

Advice on management: Deepwater sharks can sustain only very low exploitation rates. They are taken in mixed fisheries, which makes it difficult to manage them in a single-species context. Due to the declining trends in CPUE, despite the mixed nature of the catches, ICES recommends that the overall exploitation be reduced. ICES further advises that species-specific landings data be collected for all deepwater sharks to allow better understanding and quantification of the status of exploited shark species.

Relevant factors to be considered in management: Without information on trajectories of individual species' abundances, it is not possible to advise on the size of the reduction in exploitation necessary for the fisheries to be sustainable, but it is more likely to be large (e.g. 50%) than small (e.g. 10%). Moreover, due to the biology of these species, such reductions would have to be maintained for several years before the status of the more heavily exploited stocks will show evidence of recovery.

Elaboration and special comment: Deepwater sharks are taken in mixed species trawl fisheries in Subareas V, VI, VII, and XII. Furthermore, deepwater sharks are taken in longline fisheries. In these fisheries it is not possible to target squalids without a by-catch of other species.

Mixed species trawl fisheries take a substantial catch of sharks. Other species in this fishery include black scabbardfish, roundnose grenadier, forkbeard, and blue ling.

The various longline fisheries taking deepwater sharks also take forkbeards, mora, Greenland halibut, and rabbitfish. However, the species diversity in such fisheries is lower than in the trawl fisheries and sharks tend to be a more dominant proportion of the catch. The mixed species character of these trawl and longline fisheries makes them difficult to manage based on single-species advice. The multi-species nature of the fisheries also makes it hard to interpret CPUE figures, because preferred shark species may be depleted by fishing while mixed species catches may be maintained by landing of new species that previously may have been discarded, or are encountered as the fleets expand areas of operation in search of the targeted species in the complex.

There is no information on gillnet fisheries for deepwater sharks, though it is known that there are such fisheries. There is a general wish for more data on the deepwater sharks, but information on the gillnet fisheries is particularly needed.

The trawl fishery in Subareas VI and VII is dominating in exploiting deepwater sharks. In this fishery the deepwater squalids Portuguese dogfish and leafscale gulper shark are taken together with black scabbardfish, greater forkbeard, and roundnose grenadier. Catches have increased from the early 1990s to the present. There are also mixed-species longline fisheries in these Subareas.

There are fisheries for deepwater sharks also taking place in Subarea VIII, though data are limited. In Subarea IX there are directed artisanal longline fisheries and there have been declines in catches in recent years for gulper shark.

A directed longline fishery in Subarea X for the kitefin shark has ceased to exist. Market prices, rather than stock declines are thought to be the reasons for this.

The ICES Study Group in Elasmobranch Fishes met in May 2002 and, largely based on work within the EU financed project DELASS continued the development of shark assessment methodologies. Although considerable progress has been made in making input data for stock assessment of elasmobranch species available it is still the lack of data that is the main obstacle for providing adequate advice. Therefore, focus should continue to be on the collection of catch and effort data, survey data, and biological data. At this moment the best assessments are based on CPUE data in the commercial fisheries and in surveys. However, these assessments may indicate trends but do not provide the required absolute estimates.

Landings by Subarea/Division and nation are given in Table 3.13.12.1.

Sources of information: Report of the Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources, 4–10 April 2002 (ICES CM 2002/ACFM:16), Report of the Study Group on Elasmobranch Fishes, 6-10 May 2002 (ICES CM2002/G:8, ref: ACFM), Report of the Symposium on Elasmobranch Fisheries: Managing for Sustainable Use and Biodiversity Conservation.

Catch data (Table 3.13.12.1)

Year	ACFM Catch (Deepwater squalids)	ACFM Catch (Various sharks, including some deepwater squalids)
1988	2,253	5,904
1989	2,151	4,028
1990	3,871	2,394
1991	5,610	7,254
1992	7,836	10,454
1993	7,985	7,767
1994	7,474	7,621
1995	6,801	7,513
1996	7,065	7,622
1997	6,158	9,220
1998	6,318	10,009
1999	636	6,996
2000	6,392	7,443
2001*	8,199	8,929

*Preliminary. Weights in t.

Table 3.13.12.1 Working Group estimates of landings of deepwater sharks, and of sharks not elsewhere identified (various) that are known to contain some landings of deepwater species. Landings data indicated as "deep" for France, Ireland, and the UK are almost exclusively *C. coelolepis* and *C. squamosus*. In the case of other countries they may contain some other species. Data for 2001 are preliminary. "Aiguillat noir" is a new category of small squalids and are considered separately from the main commercially important squalid sharks in the summary landings tables.

Shark landings in Division IVa

Year	France		Denmark	E & W	Scotland
	Deep	Aiguillat noir	*E. spinax*	Various	Various
1991	3	-	-	-	-
1992	133	-	-	-	-
1993	51	-	27	-	-
1994	86	-	0	-	-
1995	10	-	10	-	-
1996	6	-	8	-	-
1997	-	-	32	-	-
1998	-	-	359	-	-
1999	20	-	128	-	53
2000	0	1	25	2	8
2001	0	-	52	0	10

Shark landings in Division Va

Year	Iceland		Germany
	S. microcephalus	*C. coelolepis*	Various
1989	31	-	-
1990	54	-	3
1991	58	-	133
1992	70	-	51
1993	39	-	86
1994	42	-	10
1995	45	-	6
1996	65	-	-
1997	70	-	-
1998	82	5	20
1999	45	-	0
2000	45	-	0
2001	56	-	-

Shark landings in Division Vb

Year	France	Norway	Germany	E & W		Scotland		Faroe Islands	
	Deep	Deep	Various	Deep	Various	Deep	Various	Various	*C. coelolepis*
1990	140	-	-	-	-	-	-	-	-
1991	75	-	-	-	-	-	-	3	-
1992	123	-	-	-	5	-	-	36	-
1993	91	-	2	-	9	-	-	376	-
1994	149	-	43	-	-	-	-	-	-
1995	262	-	-	-	-	-	-	-	-
1996	348	-	31	-	1	-	-	-	-
1997	261	-	27	-	20	-	-	-	-
1998	354	-	-	-	-	-	-	-	79
1999	461	-	1	-	-	-	8	-	-
2000	306	0	0	-	54	11	15	2[1]	23
2001	297	25	0	4	93	5	119	576[2]	-

[1] *Centrophorus squamosus*

[2] *Centrophorus squamosus* and *Centroscymnus coelolepis*.

Table 3.13.12.1 continued

Shark landings in Division VIa

Year	France		Ireland	Norway	Germany	E & W		Scotland	
	Deep	*A. noir*	Deep	Deep	Various	Deep	Various	Deep	Various
1999	1,651	-	-	-	-	-	-	-	136
2000	2,124	127	21	0	1	244	119	181	25
2001	2,332	120	21	149	8	98	24	386	36

Shark landings in Division VIb

Year	France		Ireland	Norway	Germany	E & W		Scotland	
	Siki	*C. fabricii*	Deep	Deep	Various	Deep	Various	Deep	Various
1999	472	-	-	-	-	-	-	-	112
2000	346	1	-	41	177	26	220	24	23
2001	247	4	5	83	34	219	168	127	8

Shark landings in Division VIb taken by Spain on Hatton Bank

Year	*C. squamosus*	*C. coelolepis*	*D. calceus*	*C. repidater*	*C.fabricii*	*Etmopterus sp.*
2000	0	33	0	0	1	0
2001	0	120	0	0	0	21

Shark landings in Subareas VI and VII

Year	France	Spain	Germany	E & W	Scotland	Faroe Islands
	Deep (VI only)	Various	Various	Various	Various	Various
1988	-	66	-	19	-	-
1989	-	-	-	32	8	-
1990	-	-	-	38	5	-
1991	944	-	-	201	53	-
1992	1,953	-	-	503	133	3
1993	2,454	-	124	821	447	-
1994	2,198	-	395	742	727	-
1995	1,784	-	2	1,315	782	-
1996	2,374	-	276	1,345	555	-
1997	2,222	152	66	2,721	301	-
1998	2,081	645	65	1,812	501	-
1999	-	199	189	1,403	-	-
2000	-	8	-	-	-	-
2001	-	0	-	-	-	-

Shark landings in Subarea VII

Year	France	France	Ireland	Germany	E & W		Scotland	
	Deep	*C. fabricii*	Deep	Various	Deep	Various	Deep	Various
1991	265	-	-	-	-	-	-	-
1992	878	-	-	-	-	-	-	-
1993	857	-	-	-	-	-	-	-
1994	1,363	-	-	-	-	-	-	-
1995	991	-	-	-	-	-	-	-
1996	754	-	-	-	-	-	-	-
1997	571	-	-	-	-	-	-	-
1998	673	-	-	-	-	-	-	-
1999	440	-	-	-	-	-	-	244
2000	506	4	92	85	23	76	0	3
2001	417	6	159	164	353	130	103	21

Table 3.13.12.1 Continued

Deepwater shark landings taken by Portugal in Division IXa

Year	*C. granulosus*	*C. squamosus*	*C. coelolepis*	*D. licha*	*G. melastomus*
1988	995	560	n/a	149	21
1989	1,027	507	n/a	57	17
1990	1,056	475	n/a	7	17
1991	801	424	651	12	17
1992	958	422	692	11	16
1993	886	339	607	11	20
1994	344	579	576	11	37
1995	423	544	810	7	29
1996	242	412	777	4	35
1997	291	384	927	4	29
1998	187	362	858	6	22
1999	92	428	544	6	23
2000	54	438	611	-	-
2001	93	510	620	7	35

Shark landings in Subareas VIII and IX

Year	Spain Various	France Deep (VIII only)	E & W Various	Scotland Various
1988	3,545	-	-	-
1989	1,789	-	-	-
1990	n/a	-	-	-
1991	2,850	-	-	-
1992	3,740	15	0	0
1993	-	9	-	0
1994	-	8	-	4
1995	-	0	32	7
1996	-	1	25	0
1997	1,059	1	20	-
1998	1,811	13	-	-
1999	476	20	-	-
2000	228	21	-	-
2001	321	5	-	-

Deepwater shark landings taken by Portugal (Azores) in Subarea X

Year	*C. squamosus*	*D. licha*
1988	-	549
1989	-	560
1990	-	602
1991	-	896
1992	-	761
1993	-	591
1994	-	309
1995	-	321
1996	-	216
1997	-	30
1998	4	34
1999	8	31
2000	-	31
2001	-	13

Table 3.13.12.1 Continued

Shark landings in Subarea XII

Year	France Deep	France *C. fabricii*	Ireland Deep	Norway Deep	E & W Various	Scotland Deep	Scotland Various
1991	1	-	-	-	-	-	-
1992	2	-	-	-	-	-	-
1993	6	-	-	-	-	-	-
1994	8	-	-	-	-	-	-
1995	139	-	-	-	-	-	-
1996	147	-	-	-	-	-	-
1997	32	-	-	-	-	-	-
1998	56	-	-	-	-	-	-
1999	50	-	-	-	-	-	-
2000	190	3	-	77	35	3	3
2001	23	2	29	142	-	36	-

Shark landings in Subarea XII caught by Spain on Hatton Bank

Year	*C. squamosus*	*C. coelolepis*	*D. calceus*	*C. repidater*	*C.fabricii*	*Etmopterus* sp
2000	34	505	12	85	84	38
2001	2	493	5	68	91	317

Summary of available landings data for large deepwater squalid sharks by Subarea/Divisions.
No data were available for VIII from most countries.

Year	IVa	Va	Vb	VI	VII	VIII	IXa Portugal	X Azores	XII	**Total**
1988	-	-	-	-	-	-	1,704	549	-	**2,253**
1989	-	-	-	-	-	-	1,591	560	-	**2,151**
1990	-	-	140	-	-	-	3,129	602	-	**3,871**
1991	3	-	75	944	265	-	3,426	896	1	**5,610**
1992	133	-	123	1,953	878	15	3,971	761	2	**7,836**
1993	51	-	91	2,454	857	9	3,926	591	6	**7,985**
1994	86	-	149	2,198	1,363	8	3,353	309	8	**7,474**
1995	10	-	262	1,784	991	0	3,294	321	139	**6,801**
1996	6	-	348	2,374	754	1	3,219	216	147	**7,065**
1997	-	-	261	2,222	571	1	3,041	30	32	**6,158**
1998	-	5	433	2,081	673	13	3,019	38	56	**6,318**
1999	20	-	461	2,123	440	20	2,483	39	50	**636**
2000	1	-	342	3,010	621	21	2,173	31	951	**6,392**
2001*	0	-	907	3,679	1,032	5	2,333	13	1,206	**8,199**

* Preliminary.

Total sharks (various, including some deepwater sharks) landings by Subareas/Divisions.

Year	IVa	Va	Vb	VI	VII	VI&VII	VIII&IX	XII	**Total**
1988						85	3,545		**5,904**
1989		31				40	1,789		**4,028**
1990		54	140			43	1,789		**2,394**
1991	3	58	78	944	265	254	2,850	1	**7,254**
1992	133	70	164	1,953	878	639	6,590	2	**10,454**
1993	78	39	478	2,454	857	1,392	3,740	6	**7,767**
1994	86	42	192	2,198	1,363	1,864	4	8	**7,621**
1995	20	45	262	1,784	991	2,099	43	139	**7,513**
1996	14	65	380	2,374	754	2,176	64	147	**7,622**
1997	32	70	308	2,222	571	3,240	1,104	32	**9,220**
1998	359	87	433	2,081	673	3,023	2,890	56	**10,009**
1999	201	45	470	2,371	440	1,791	2,287	50	**6,996**
2000	36	45	409	3,704	789	8	704	1,069	**7,443**
2001*	62	57	543	4,102	1,353	0	549	1,208	**8,929**

* Preliminary.

3.14 Stocks in the Baltic

3.14.1 Overview (Including overview of Salmon and Sea trout)

The main fisheries for cod in the Baltic use demersal trawls, high opening trawls (operating both pelagically and demersally), and gillnets. There has been an increase in gillnet fisheries in the 1990s and the share of the total catch of cod taken by gillnets has in recent years been about 35-50%. The Baltic herring is exploited mainly by pelagic trawls and demersal trawls and, during the spawning season, by trapnets/pound-nets in coastal areas. The herring trawl fishery is largely a mixed herring and sprat fishery where the share of herring varies significantly by Subdivisions and seasons. The main part of the sprat catch is taken by pelagic pair trawling and are used for industrial purposes. There has been an increase in catches of sprat in the most recent years, and 1997 catches were at a record high of 529 000 t for the whole Baltic. The sprat catches have since decreased continuously to 342 000 t in 2001. Baltic salmon is exploited by drift net, trapnet, and longline fisheries.

An overview of catches of fish in the Baltic until 2000 as officially reported to ICES, is given in Section 3.14.2.

For Baltic **cod** there is one management unit covering all Subdivisions 22–32. ICES considers the stocks in Subdivisions 22–24 and Subdivisions 25–32 as separate stocks, however, and advice is provided on them separately.

ICES reiterates its advice that the cod stocks should be managed separately in order to better adapt the exploitation to the present development in the two stocks.

IBSFC has in September 1999 adopted a **Long-Term Management Strategy for the Cod Stocks in the Baltic Sea:**

The IBSFC agreed to implement a long-term management plan for the two cod stocks, Eastern and Western stocks, as defined by ICES, which is consistent with a precautionary approach and designed to ensure a rational exploitation pattern and provide for stable and high yield. The plan shall consist of the following elements:

1. *Every effort shall be made to maintain a minimum level of Spawning Stock Biomass (SSB) greater than 160 000 tonnes for the Eastern stock and 9 000 tonnes for the Western stock.*

2. *A long-term management plan shall be implemented, by which annual quotas shall be set for the fishery on the Eastern stock, reflecting a fishing mortality rate of 0.6, and for the Western stock 1.0, both for appropriate age groups as defined by ICES.*

3. *Should the SSB fall below a reference point of 240 000 tonnes for the Eastern stock and 23 000 tonnes for the Western stock, the fishing mortality rates referred to under paragraph 2 will be adapted in the light of scientific estimates of the conditions then prevailing, to ensure safe and rapid recovery of spawning stock biomasses to levels in excess of 240 000 tonnes and 23 000 tonnes, respectively, for the Eastern and Western stocks.*

4. *For allocation purposes, a combined TAC will be established. The Contracting Parties agree to further collaborate, inter alia, through bilateral agreements to ensure an efficient management of the cod stocks.*

5. *The exploitation pattern in the fisheries for cod and in particular, the selectivity shall be improved in the light of new scientific advice from ICES with the objective to enhance the spawning biomass of cod and reduce discards.*

6. *Additional technical measures including, inter alia, further limitation on effort, restrictions on fishing days, closing of areas and/or seasons, obligation to change fishing ground in case of high abundance of juveniles, special reporting requirements, and other appropriate control measures should be considered.*

7. *The IBSFC shall, as appropriate, adjust management measures and elements of the plan on the basis of any new advice provided by ICES.*

A review of this arrangement shall take place no later than year 2003.

IBSFC has in September 2001 adopted a **Recovery Plan for the Baltic Cod:**

In conformity with the Long Term Management Strategy for Baltic Cod the Contracting Parties agree to establish a recovery plan for the Baltic cod. They also took note that the spawning biomass of the Western stock is above the agreed $\boldsymbol{B}_{pa}$. The plan shall include the following elements.

I

1. *For 2002 the fishing mortality for the Eastern stock shall be reduced to below* $\boldsymbol{F_{pa}}$ *and shall not be greater than 0.55 within a global TAC of 76 000 tonnes;*

2. *Manage the fishery for Eastern cod stock in year 2003 and subsequent years with the objective of reducing the fishing mortality for Eastern cod stock to below* $\boldsymbol{F_{pa}}$ *in order to ensure safe and rapid recovery of the spawning stock to levels in excess of 240 000 tonnes;*

3. *Request ICES to evaluate the findings of the IBSFC Scientific Meeting on Technical Measures for the Fisheries on Baltic Cod (Brussels 20 - 24 August 2001) and to provide advice and catch options for 2003 and subsequent years taking into account improved selectivity and additional technical measures;*

II

1. *Extend the summer ban to the period from 1 June to 31 August;*

2. *Establish spawning area closures in the Bornholm Deep;*

3. *Establish additional spawning area closures in the Gdansk Deep and the Gotland Deep in the case of new scientific information;*

4. *Fix the minimum mesh size for gill nets to 110 mm to be implemented from 1 September 2002;*

5. *Establish the maximum length of gill nets per vessel fishing for cod :*

   A. *For vessels with an overall length of up to and including 12 m limit the use of nets to a maximum length of 12 km;*

   B. *For vessels with an overall length of more than 12 m limit the use of nets to a maximum length of 24 km;*

6. *Establish a soak time when fishing with gillnets of a maximum of 48 hours, the start and recovery time to be recorded in the fishing logbook;*

7. *Improve the marking system and introduce a tagging system for gillnets;*

8. *Review the minimum landing size for Cod in the Baltic in the light of experience with the use of fishing gears with improved selectivity*

9. *Set the by-catch of cod (in weight) in the herring and sprat fisheries at 3 per cent of which a maximum of 5 per cent may be of undersized cod,*

10. *Delete Fishing Rule 8.2, thereby prohibiting the landing of undersized cod;*

11. *Request ICES to review all relevant data related to the selectivity of cod in the Baltic sea and to revisit the mesh size of the diamond 130 mm mesh size with a view to establishing a mesh size ensuring a similar selectivity as the 120 mm BACOMA window;*

12. *Request the Working Group on Fisheries Rules to consider additional technical measures and provide proposals for amendments relating to fisheries rules that have an impact on cod with the view to improving the recovery plan;*

III

1. *Establish a comprehensive and efficient Control and Enforcement scheme (Action Plan) to support the cod recovery plan consisting of the following main elements:*

   a. *Inspection Strategy.*

   b. *Co-operation which will include, where practical, an exchange of fisheries inspectors on a bilateral basis in 2002 and in subsequent years.*

   c. *Evaluation of the efficiency of the measures taken.*

2. *In order to enforce the implementation of the cod recovery plan the Parties will notify the Secretariat of IBSFC of the results of the Action Plan. The IBSFC Secretariat will present a Report of the Action Plan at the 28th Session of IBSFC.*

For **cod**, unusually strong year classes in 1976, 1979, and 1980 formed the basis for an increase in the stock in the eastern Baltic and an expansion in the fisheries. Catch levels more than doubled and the fishery attracted vessels from other Baltic fisheries and from fleets normally operating outside the Baltic Sea. , In almost all years landings have been far above the levels recommended by ICES. The decline in stock size and landings started around 1985 and continued up to 1992. Fleet capacity and fishing effort have now been reduced to some extent, but fishing mortality increased as the stocks declined. Improved recruitment in the early 1990s has resulted in spawning stock biomasses increasing above the 1992 minimum, and this increase has been seen especially in the western Baltic cod stock. After a slight increase in 1994–1995, the SSB of the eastern Baltic cod stock has decreased again in 1999-2001 to a historically low level.

The success of cod reproduction is, among other things, dependent on certain minimum levels of salinity and oxygen concentration for the fertilisation and survival of the eggs and larvae. The unusually long period with low influx of North Sea water from the late 1970s to the early 1990s was in general a period of low recruitment. The influx in 1993 resulted in improved environmental conditions, which allowed the possibility of improved recruitment but did not secure it. Since 1993 there have not been major influxes. The effect of an intrusion of North Sea water into the Baltic Sea is usually sufficient to support better environmental conditions for two spawning seasons (about 1.5 years) at the most, because after that period the salinity and oxygen levels in the deep water layers decrease below the level at which cod eggs can survive.

The recent improvement in recruitment and the reversal of the downward trend in spawning stock biomass has been seen in both the Western (Subdivisions 22 and 24) in 1994–1997 and Eastern (Subdivisions 25–32) cod stocks in 1994–1995. However, fishing mortalities are still estimated to be high in the Western stock and have increased in the Eastern stock from a lower level. In the Western stock the increase in spawning stock biomass in recent years was caused mainly by the 1994 year class, and it is expected that the spawning stock biomass will increase with the present exploitation pattern, due to the 1997 year class, which is estimated to be above average. The Eastern stock has been below the long-term average since 1986, and thus a recovery of the stock can hardly be expected with the present exploitation pattern and tendency for fishing mortality to increase. It is therefore considered that reductions in fishing effort is needed if these stocks are to recover on a more permanent basis.

The landings of **sprat** for industrial purposes have increased markedly during the last decade. **Herring** and sprat are used mainly for human consumption when landed in the countries on the eastern Baltic coasts, but for production of fishmeal and oil in the countries on the west coast.

Herring in the Baltic is assessed as five stocks. This is to be regarded as a compromise between using the larger number of stocks/populations that have been identified for biological reasons and the practical constraints, e.g. in what units are catch figures available, and what are the possibilities for correctly allocating individual fish to particular stocks.

Sprat is assessed as one unit for the entire Baltic.

The exploitation rate of pelagic stocks in the Baltic has increased since the mid-1990s. Due to the low abundance of cod the natural mortality of Baltic herring and sprat is low at present. The Baltic sprat is considered to be harvested inside safe biological limits. A sharp decrease in mean weight at age of sprat has been observed since 1993. A continuous decreasing trend in mean weight at age has been observed in most herring stocks in the Baltic since the mid-1980s. This decline in mean weight at age partly explains the declining trend in biomass of the herring stock in Central Baltic herring in Subdivisions 25–29, 32. At the present the mean weight of herring remains at a low level. Still, there have been some indications in the last few years that the decreasing trend of the mean weight is slowing down. Due to the decreasing SSB and increasing trend in fishing mortality the Central Baltic herring is assumed to be outside of biological limits. Different trends of stock development have been observed for herring in the Gulf of Riga and for herring in the Bothian Sea (Subdivision 30). Based on prevalence of abundant year classes during the 1990s SSB of the Gulf of Riga herring has increased significantly and presently is historically high (120-130 thousand t). Herring in Bothnian Sea after increase of recruitment abundance during the 1990s also remains at a relatively high level of 240 000 t. It has, for several reasons, been difficult to estimate the absolute stock size for the pelagic stocks, although the development of stock size in relative terms is better described. Inconsistencies between years in the results from acoustic surveys and low precision in the estimates of species composition in the mixed fisheries have contributed to the variation in stock estimates given during the latest years. However, a fourfold increase in sprat catches between 1991 and 1997 has been observed and the development of this fishery, and consequently the rate of fishing mortality, should be closely monitored.

The multispecies interactions may periodically have a strong influence on the state of fish stocks in the Baltic, depending on the abundance of cod as the main predator in the Baltic Sea ecosystem. To take into account the multispecies effects, the data from multispecies assessment methods are used in the assessment of pelagic stocks. However, interactions with other potential top predators, such as salmon and seal that are potentially important in the northern Baltic Sea, are not yet quantified and are therefore not directly included in the present ICES advice.

The spring-spawning herring stock in Subdivisions 22–24 and Division IIIa migrates after the spawning season into the Kattegat, the Skagerrak, and the eastern parts of the North Sea, where it mixes with the North Sea autumn-spawning herring stock during the feeding period. Difficulties in allocating catches to the Baltic spring-spawning stock and to the considerably larger North Sea stock, uncertain catch statistics, and conflicting trends in survey indices have resulted in unreliable assessments for the spring-spawning stock of herring in Subdivisions 22–24 and Division IIIa. Improvements in methods of stock separation applied for 1991-2001 have, however, resulted in an acceptable assessment in 2002.

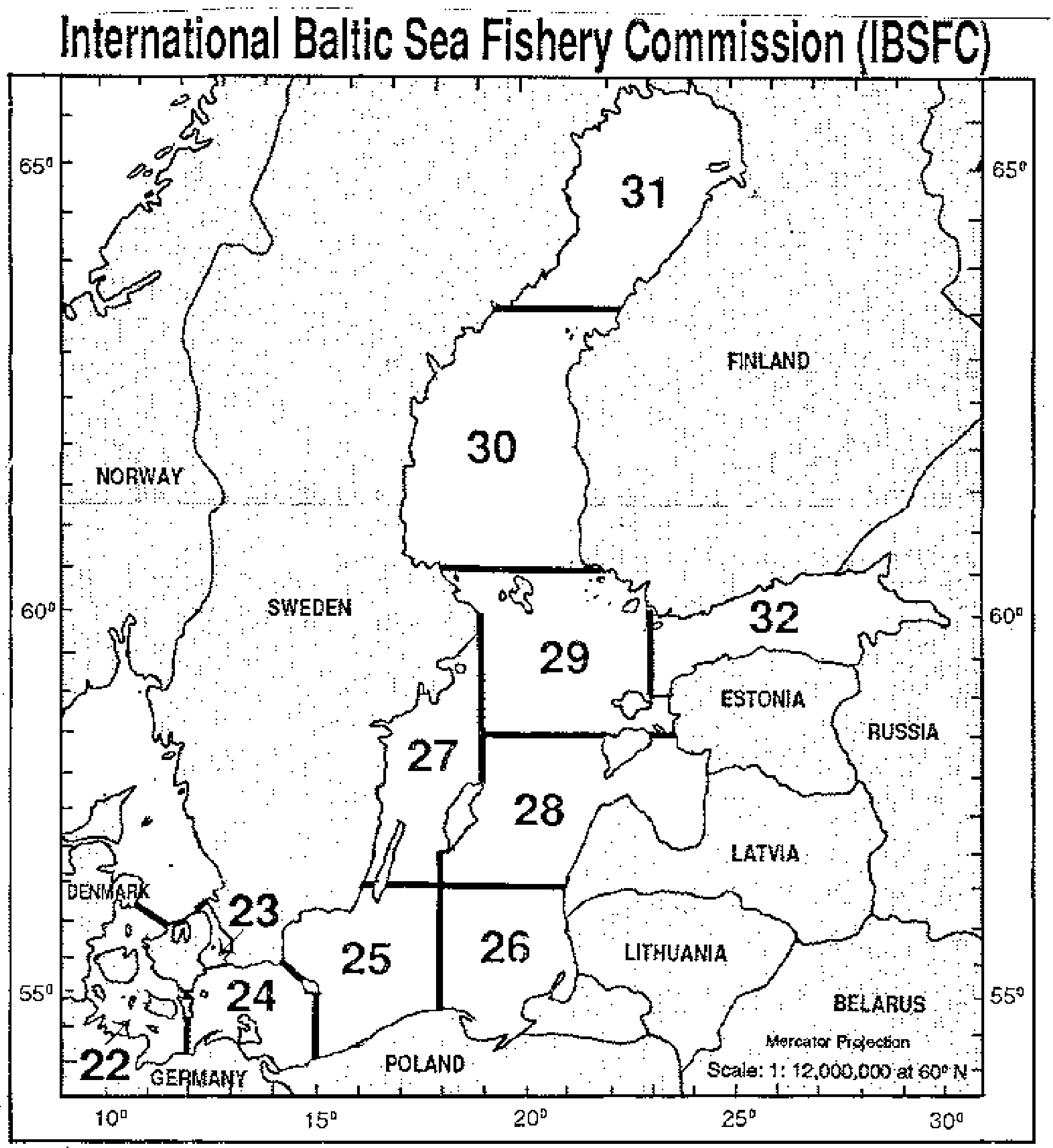


Figure 3.14.1.1

Salmon and Sea Trout

Salmon

There are 40–50 rivers in the Baltic Sea with wild salmon smolt production (Figure 3.14.1.2). Many rivers have been dammed and spawning and nursery areas have been completely or partially destroyed. To compensate, hatcheries have been built on these rivers where fish are reared to the smolt stage before release. These fish feed in the sea mainly in the Baltic Main Basin and migrate back to rivers as spawners, where they are used as broodstock to a varying extent. In some rivers with compensatory releases, some homing salmon succeed to reproduce so that there is small amount of natural reproduction. A major part of wild and reared smolt production takes place in the Gulf of Bothnia.

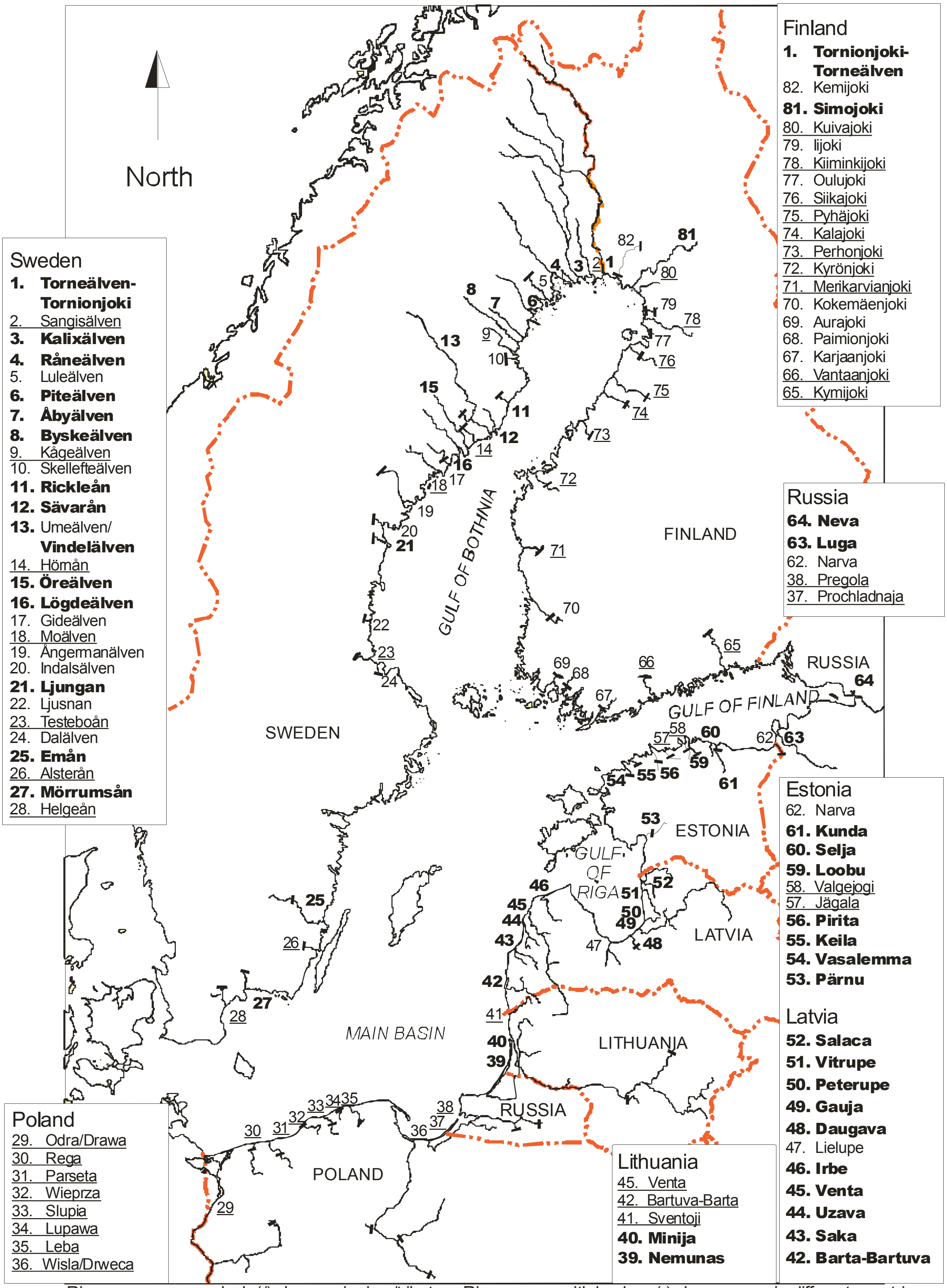
While feeding in the sea, salmon are caught by driftnets and longlines and, during the spawning run, they are caught along the coast, mainly in trap nets and fixed gillnets and, to a minor extent, in a trolling fishery. Where fisheries are allowed in the river mouths, set gillnets and trapnets are used. In Sweden and Finland, there is also a traditional recreational angling and gillnet fishery in some of the rivers. In Sweden, there is a considerable broodstock fishery in rivers having reared populations. The offshore fishery and most of the coastal fisheries exploit both wild and reared salmon. Wild salmon can normally not be distinguished from reared fish in the fisheries.

There are two IBSFC management areas for salmon in the Baltic Sea: (1) Main Basin and Gulf of Bothnia (Subdivisions 22-29 and 30–31, respectively) and (2) Gulf of Finland (Subdivision 32). The offshore and coastal fisheries have been managed by a single TAC since 1991. The overall management objective of IBSFC to increase the production of wild Baltic salmon is to attain at least 50% of the natural production capacity of each river with current or potential production of salmon by 2010, while maintaining the catch level as high as possible.

Sea trout

There are wild sea trout populations in approximately 400 rivers and streams in the Baltic Sea. Similar to the situation for salmon rivers, sea trout rivers have been dammed and natural reproductive capacity has ceased. Reared smolts are released to compensate for these losses. Sea trout are also in many cases released to provide recreational fishery on returning spawners. Most of the stocks remain in the coastal area within about 150 km of the point of release, but a high proportion of those from Poland and some from southern Sweden migrate further into offshore areas. Coastal populations are mainly taken as by-catch in gillnets or trapnets. The stocks entering the offshore area are exploited by salmon drift netting and longlines. Sea trout are important for the recreational fishery in coastal areas and rivers.

The populations in the Gulf of Bothnia, particularly those in Subdivision 31, are in a poor state. Several of these populations are overexploited in the sea to the extent that they now exist mainly as non-migratory brown trout populations. The state of the populations in the remainder of the Baltic Sea is variable, but in general better than in the Gulf of Bothnia. IBSFC has not established any management objectives for sea trout.



River names a slash (/) show main river/tributary. River names with hyphen (-) show names in different countries.

Figure 3.14.1.2 Baltic salmon rivers divided into three categories (see above figure). Only lower parts of rivers with current salmon production or potential for production of wild salmon are shown. The presence of dams, which prevents access to areas, is indicated by lines across rivers. *Notation:* **river name in bold** = *river with wild smolt production*; river name underlined = *river with potential for establishment of wild salmon*; normal font = *river with releases, no natural reproduction.*

3.14.2 Nominal catches in the Baltic Area

Officially reported catches in the Baltic until 2000 are given in Tables 3.14.2.1–5. These are the catches officially reported to ICES by national statistical offices for publication in the *ICES Fishery Statistics.*

In the assessments, the working groups try to estimate discards and slipped fish, landings which are not officially reported, and the composition of by-catches. These amounts are included in the estimates of total catch for each stock and are used in the assessments; thus, they appear in the tables and figures produced by working groups. These estimates vary considerably between different stocks and fisheries, being negligible in some cases and constituting important parts of the total removals from other stocks. Further, the catches used by the working groups are broken down into subdivisions, whereas the officially reported catches by some countries are reported by the larger Divisions IIIb, c, and d. The trends in Tables 3.14.2.1–5 may, therefore, not correspond to those on which assessments have been based, and are presented for information only, without any comment from ACFM.

The 1990 catches listed under the Federal Republic of Germany and the German Democratic Republic refer to catches by vessels from the respective former territories during the whole of 1990, before and after political union. Thus, catches taken by vessels registered in the former German Democratic Republic in the months after unification are included in the German Democratic Republic figures.

The catch data used in the assessments are given in other tables.

Table 3.14.2.1 Nominal fish catches in the Baltic from 1973-2000 (in '000 t). Anadromous species, except salmon, are not included. (Data as officially reported to ICES.)

Year	Species							Total
	Cod	Herring	Sprat	Flatfish	Salmon	Freshwater species	Others	
1973	189	404	213	18	2.7	23	55	905
1974	189	407	242	21	2.9	21	54	937
1975	234	415	201	24	2.9	20	60	957
1976	255	393	195	19	3.1	21	46	932
1977	213	413	211	22	2.4	22	42	925
1978	196	420	132	23	2.0	22	44	839
1979	273	459	78	24	2.3	20	47	903
1980	388	453	57	18	2.4	14	29	961
1981	380	419	47	16	2.4	13	31	908
1982	361	442	45	17	2.2	13	30	910
1983	376	459	31	16	2.4	13	20	917
1984	442	426	52	15	3.7	13	17	969
1985	344	431	69	17	4.0	11	16	892
1986	271	401	75	18	3.5	12	19	800
1987	238	373	91	16	3.8	13	24	759
1988	225	407	86	14	3.2	13	31	779
1989	192	414	89	14	4.2	14	18	745
1990	167	360	92	12	5.6	11	18	666
1991[1]	139	295	111	14	4.6	17	19	600
1992[1]	72	339	146	12	4.7	8	13	595
1993[1]	41	352	194	12	3.4	10	7	619
1994[1]	75	353	301	18	2.9	9	8	767
1995[1]	117	343	326	22	2.7	9	17	837
1996[1]	164	326	464	22	2.6	9	6	994
1997[1]	134	370	520	20	2.6	12	7	1,066
1998[1]	103	383	446	18	2.1	11	3	966
1999	117	343	408	18	1.7	11	4	903
2000[2]	105	371	369	20	2.0	20	13	900

[1]Preliminary

[2]Includes recreational catches from Finland

Table 3.14.2.2 Nominal catch (tonnes) of HERRING in Divisions IIIb,c,d 1963-2000. (Data as officially reported to ICES.)

Year	Denmark	Finland	German Dem.Rep.	Germany, Fed.Rep.	Poland	Sweden	USSR	Total
1963	14,991	48,632	10,900	16,588	28,370	27,691	78,580[1]	225,752
1964	29,329	34,904	7,600	16,355	19,160	31,297	84,956	223,601
1965	20,058	44,916	11,300	14,971	20,724	31,082[2]	83,265	226,216
1966	22,950	41,141	18,600	18,252	27,743	30,511	92,112	251,309
1967	23,550	42,931	42,900	23,546	32,143	36,900	108,154	310,124
1968	21,516	58,700	39,300	16,367	41,186	53,256	124,627	354,952
1969	18,508	56,252	19,100	15,116	37,085	30,167	118,974	295,202
1970	16,682	51,205	38,000	18,392	46,018	31,757	110,040	312,094
1971	23,087	57,188	41,800	16,509	43,022	32,351	120,728	334,685
1972	16,081	53,758	58,100	10,793	45,343	41,721	118,860	344,656
1973	24,834	67,071	65,605	8,779	51,213	59,546	127,124	404,172
1974	19,509	73,066	70,855	9,446	55,957	60,352	117,896	407,081
1975	18,295	69,581	71,726	10,147	68,533	62,791	113,684	414,757
1976	23,087	75,581	58,077	6,573	63,850	41,841	124,479	393,488
1977	25,467	78,051	62,450	7,660	60,212	52,871	126,000	412,711
1978	26,620	89,792	46,261	7,808	63,850	54,629	130,642	419,602
1979	33,761	83,130	50,241	7,786	79,168	86,078	118,655	458,819
1980	29,350	74,852	59,187	9,873	68,614	92,923	118,074	452,873
1981	28,424	65,389	56,643	9,124	64,005	84,500	110,782	418,867
1982	40,289	73,501	50,868	8,928	76,329	92,675	99,175	441,765
1983	32,657	83,679	51,991	9,273	82,329	86,561	112,370	458,860
1984	32,272	86,545	50,073	8,166	78,326	65,519	105,577	426,478
1985	27,847	88,702	51,607	9,079	85,865	57,554	110,783	431,437
1986	21,598	83,800	53,061	9,382	77,109	39,909	115,665	400,524
1987	23,283	82,522[3]	50,037	6,199	60,616	36,446	113,844	372,947
1988	29,950	92,824[3]	53,539	5,699	60,624	41,828	122,849	407,313
1989	26,654	81,122[3]	54,828	5,777	58,328	65,032	121,784	413,525
1990	16,237	66,078[3]	40,187	5,152	60,919	55,174	116,478	360,225

Year	Denmark	Estonia	Finland	Germany	Latvia	Lithuania	Poland	Sweden	Russia	Total
1991	23,995	27,034[4]	51,546[3]	16,022	33,270	6,468[5]	45,991	59,176	31,755	295,257[6]
1992	33,855	29,556	72,171[3]	17,746	25,965	3,237[6]	52,864	75,907	27,979	339,280[6]
1993	34,945	32,982	77,353[3]	20,143	21,949	3,912[6]	50,833	86,497	23,545	352,159[6]
1994	45,190	34,493	97,674[3]	12,367	22,676	4,988[6]	49,111	70,886	15,904	353,411[6,7]
1995	37,762	43,482	94,613[3]	7,898	24,972	3,706[6]	45,676	68,019	16,970	343,099[6]
1996	34,340	45,296	93,337[3]	7,737	27,523	4,257[6]	31,246	67,116	14,780	325,632[6]
1997	30,876	52,436	90,334[3]	12,755	29,330	3,321[6]	28,939	110,463	11,801	370,255[6]
1998	38,800	42,721	85,545[3]	9,514	24,417	2,368[6]	21,873	147,706	10,544	383,488[6]
1999	37,974	44,039	82,237[3]	10,115	27,163	1,313	19,229	108,316	12,756	343,142
2000	49,727	41,735	81,648[3,8]	9,475	26,768	1,198	24,516	120,887	15,063	371,017

[1]Including Division IIIa.
[2]Large quantity of herring used for industrial purposes is included with "Unsorted and Unidentified Fish".
[3]Includes some by-catch of sprat.
[4]As reported by Estonian authorities; 32,683 t reported by Russian authorities.
[5]As reported by Lithuanian authorities; 6,456 t reported by Russian authorities.
[6]Preliminary.
[7]Includes catches from the Faroe Islands of 122 t.
[8]Includes recreational catches of 951 t.

Table 3.14.2.3 Nominal catch (tonnes) of SPRAT in Divisions IIIb,c,d 1963–2000. (Data as officially reported to ICES.)

Year	Denmark	Finland	German Dem.Rep.	Germany, Fed.Rep.	Poland	Sweden	USSR	Total
1963	2,525	1,399	8,000	507	10,693	101	45,820[1]	69,045
1964	3,890	2,111	14,700	1,575	17,431	58	55,753	95,518
1965	1,805	1,637	11,200	518	16,863	46	52,829	84,898
1966	1,816	2,048	21,200	66	13,579	38	52,407	91,454
1967	3,614	1,896	11,100	2,930	12,410	55	40,582	72,587
1968	3,108	1,291	10,200	1,054	14,741	112	55,050	85,556
1969	1,917	1,118	7,500	377	17,308	134	90,525	118,879
1970	2,948	1,265	8,000	161	20,171	31	120,478	153,054
1971	1,833	994	16,100	113	31,855	69	133,850	184,814
1972	1,602	972	14,000	297	38,861	102	151,460	207,294
1973	4,128	1,854	13,001	1,150	49,835	6,310	136,510	212,788
1974	10,246	1,035	12,506	864	61,969	5,497	149,535	241,652
1975	9,076	2,854	11,840	580	62,445	31	114,608	201,434
1976	13,046	3,778	7,493	449	56,079	713	113,217	194,775
1977	16,933	3,213	17,241	713	50,502	433	121,700	210,735
1978	10,797	2,373	13,710	570	28,574	807	75,529	132,360
1979	8,897	3,125	4,019	489	13,868	2,240	45,727	78,365
1980	4,714	2,137	151	706	16,033	2,388	31,359	57,488
1981	8,415	1,895	78	505	11,205	1,510	23,881	47,489
1982	6,663	1,468	1,086	581	14,188	1,890	18,866	44,742
1983	2,861	828	2,693	550	8,492	1,747	13,725	30,896
1984	3,450	374	2,762	642	10,954	7,807	25,891	51,880
1985	2,417	364	1,950	638	22,156	7,111	34,003	68,639
1986	5,693	705	2,514	392	26,967	2,573	36,484	75,328
1987	8,617	287[2]	1,308	392	34,887	870	44,888	91,249
1988	6,869	495[2]	1,234	254	25,359	7,307	44,181	85,699
1989	9,235	222[2]	1,166	576	20,597	3,453	53,995	89,244
1990	8,858	162[2]	518	905	14,299	7,485	59,737	91,964

Year	Denmark	Estonia	Finland	Germany	Latvia	Lithuania	Poland	Sweden	Russia	Total
1991	21,781	14,124[3]	99[2]	736	17,996[4]	3,569	23,200	8,328	20,736	110,569[5]
1992	28,210	4,140	893[2]	608	17,388	1,697[5]	30,126	53,558	9,851	146,471[5]
1993	27,435	5,763	206[2]	8,267	12,553	2,798[5]	33,701	92,416	10,745	193,884[5]
1994	69,644	9,079	497[2]	374	20,132	2,789[5]	44,556	135,779	16,719	300,535[5,6]
1995	76,420	13,052	4,103[2]	230	24,383	4,799[5]	37,280	150,435	14,934	325,636[5]
1996	123,549	22,493	14,351[2]	161	34,211	10,165[5]	77,472	163,087	18,287	463,776[5]
1997	153,765	39,692	19,852[2]	428	49,314	6,000[5]	105,298	123,207	22,194	519,750[5]
1998	111,003	32,165	27,014	4,551	44,858	5,132[5]	59,091	141,209	21,078	446,122[5,7]
1999	97,686	36,407	18,886[2]	182	42,834	3,117	71,705	106,000	31,627	408,444
2000	55,521	41,394	23,242[2,8]	22	46,186	1,682	84,325	85,981	30,369	368,722

[1]Including Division IIIa.
[2]Some by-catch of sprat included in herring.
[3]As reported by Estonian authorities; 17,893 t reported by Russian authorities.
[4]As reported by Latvian authorities; 17,672 t reported by Russian authorities.
[5]Preliminary.
[6]Includes catches from the Faroe Islands of 966 t.
[7] Includes catches from the Faroe Islands of 21 t.
[8]Includes recreational catches of 108 t.

Table 3.14.2.4 Nominal catch (tonnes) of COD in Divisions IIIb,c,d 1963–2000. (Data as officially reported to ICES.)

Year	Denmark	Faroe Islands	Finland	German Dem.Rep.	Germany Fed.Rep.	Poland	Sweden	USSR	Total
1963	35,851		12	7,800	10,077	47,514	22,827	30,550[1]	154,631
1964	34,539		16	5,100	13,105	39,735	16,222	24,494	133,211
1965	35,990		23	5,300	12,682	41,498	15,736	22,420	133,649
1966	37,693		26	6,000	10,534	56,007	16,182	38,269	164,711
1967	39,844		27	12,800	11,173	56,003	17,784	42,975	180,606
1968	45,024		70	18,700	13,573	63,245	18,508	43,611	202,731
1969	45,164		58	21,500	14,849	60,749	16,656	41,582	200,558
1970	43,443		70	17,000	17,621	68,440	13,664	32,248	192,486
1971	47,563		3	9,800	14,333	54,151	12,945	20,906	159,701
1972	60,331		8	11,500	13,814	56,746	13,762	30,140	186,301
1973	66,846		95	11,268	25,081	49,790	16,134	20,083	189,297
1974	58,659		160	9,013	20,101	48,650	14,184	38,131	188,898
1975	63,860		298	14,740	21,483	69,318	15,168	49,289	234,156
1976	77,570		278	8,548	24,096	70,466	22,802	51,516	255,276
1977	74,495		310	10,967	31,560	47,703	18,327	29,680	213,042
1978	50,907		1,446	9,345	16,918	64,113	15,996	37,200	195,925
1979	60,071		2,938	8,997	18,083	79,697	24,003	78,730	272,519
1980	76,015	1,250	2,317	7,406	16,363	123,486	34,089	124,359	388,186[2]
1981	93,155	2,765	3,249	12,938	15,082	120,942	44,300	87,746	380,177
1982	98,230	4,300	3,904	11,368	19,247	92,541	44,807	86,906	361,303
1983	108,862	6,065	4,677	10,521	22,051	76,474	54,876	92,248	375,774
1984	121,297	6,354	5,257	9,886	39,632	93,429	65,788	100,761	442,404
1985	107,614	5,890	3,793	6,593	24,199	63,260	54,723	78,127	344,199
1986	98,081	4,596	2,917	3,179	18,243	43,237	48,804	52,148	271,205
1987	85,544	5,567	2,309	5,114	17,127	32,667	50,186	39,203	237,717
1988	75,019	6,915	2,903	4,634	16,388	33,351	58,027	28,137	225,374
1989	66,235	4,499	1,913	2,147	14,637	31,855	55,919	14,722	191,927
1990	56,702	3,558	1,667	1,630	7,225	28,730	54,473	13,461	167,446

Year	Denmark	Estonia	Faroe Islands	Finland	Germany	Latvia	Lithuania	Poland	Sweden	Russia	Total
1991	50,640	1,805[3]	2,992	1,662	8,637	2,627	1,849	25,748	39,552	3,196	138,708[4]
1992	30,418	1,369	593	460	6,668	1,250	874[4]	13,314	16,244	404	71,594[4]
1993	10,919	70	558	203	5,127	1,333	904[4]	8,909	12,201	483	40,707[4]
1994	19,822	905	779	520	7,088	2,379	1,886[4]	14,426	25,685	1,114	74,604[4]
1995	34,612	1,049	777	1,851	14,681	6,471	3,629[4]	25,001	27,289	1,612	117,265[4,5]
1996	48,505	1,392	714	3,132	20,607	8,741	5,521[4]	34,856	36,932	3,304	163,993[4,5]
1997	42,581	1,173	33	1,537	14,483	6,187	4,497[4]	31,659	29,329	2,803	134,282[4]
1998	29,476	1,070	-	1,033	10,989	7,778	4,187[4]	25,778	17,665	4,599	102,575[4]
1999	38,169	1,060	-	1,570	15,439	6,914	4,371	26,581	17,476	5,211	116,791
2000	32,049	513	n/a	1,824[6]	13,079	6,280	4,721	22,120	19,801	4,669	105,056

[1]Including Division IIIa.
[2]Includes catches from United Kingdom (England & Wales) of 2,901 t.
[3]As reported by Estonian authorities; 1,812 t reported by Russian authorities.
[4]Preliminary.
[5]Includes preliminary catches from Norway of 293 t for 1995 and 289 t for 1996.
[6]Includes recreational catches of 6 t.

3.14.3 Herring in Subdivisions 22–24 and Division IIIa (spring spawners)

State of stock/exploitation: SSB has been relatively stable over the last five years, but the stock is being harvested outside of biological limits. Fishing mortality is 0.50 for adults and 0.25 for the juveniles (0- and 1-ringers), which is substantially greater than $\mathbf{F}_{max}$. The age structure in the catch appears to be relatively stable over the last four years.

Management objectives: There are no explicit management objectives for this stock.

Precautionary Approach reference points: Precautionary Approach reference points have not been defined. The continued development of an analytical assessment may allow definition of PA reference points in the near future. Based on a comparison to other herring stocks all likely candidates of $\mathbf{F}_{pa}$ will be less than $\mathbf{F}_{max}$.

Advice on management: ICES recommends that the fishing mortality be reduced to less than $\mathbf{F}_{max}$, corresponding to catches in 2003 of less than 84 000 t. According to the recent geographic distribution of catches, approximately half of the total catch should be taken from the Subdivisions 22–24.

Relevant factors to be considered in management: Section (3.5.8) on North Sea herring (autumn spawners) states: "The fisheries on herring in Division IIIa should be managed in accordance with the management advice given on spring spawning herring", and the North Sea stock is now above $\mathbf{B}_{pa}$. A considerable part of the landings of juvenile herring in Division IIIa originates from the North Sea stock. An abundant 2000 year class of North Sea autumn spawner herring is expected to be present in the area as one-winter-ringers in 2002. The 2001 North Sea autumn spawner year class also appears to be abundant and this year-class will be present in Div. IIIa as 0-ringers in 2002. Recently, this fishery has been managed in a manner consistent with the management of the herring in the North Sea. As the North Sea stock recovers, the need for a separate management of Subdivisions 22–24 + Division IIIa herring stock increases.

In the Baltic the TACs for herring apply to several herring stocks, including the component of this stock in Subdivisions 22–24, and there is no specific instrument that allows control over the exploitation of spring-spawning herring in Division IIIa and Subdivisions 22–24. The herring TAC for the Baltic should be split and individual TACs applied to the stocks, i.e. Subdivisions 22–24, Subdivisions 25–29 + 32 (excluding Gulf of Riga herring), Gulf of Riga herring, Subdivision 30 and Subdivision 31.

Catch forecast for 2003: Basis: F(2002) = $\mathbf{F}_{sq}$ = F(1999–2001) = 0.498; Landings (2002) = 107; SSB(2002) = 140.

F(2003 onwards)	Basis	SSB (2003)	Landings (2003)	SSB (2004)
0	$0\mathbf{F}_{sq}$	141	0	224
0.202	$\mathbf{F}_{0.1}$	139	48	183
0.3	$0.6\mathbf{F}_{sq}$	136	69	166
0.372	$\mathbf{F}_{max}$	136	84	154
0.398	$0.8\mathbf{F}_{sq}$	135	89	150
0.448	$0.9\ \mathbf{F}_{sq}$	135	98	143
0.498	$\mathbf{F}_{sq}$	134	107	136
0.547	$1.1\ \mathbf{F}_{sq}$	133	116	129

Weights in '000 t.
Shaded scenarios considered inconsistent with the precautionary approach.

Comparison with previous assessment and advice: The assessment carried out in 2002 is the first accepted analytical assessment. The results are very similar to a provisional assessment provided last year.

Elaboration and special comments: Herring of this stock are taken in the Northeastern part of the North Sea, Division IIIa, and Subdivisions 22–24. Division IIIa has directed fisheries by trawlers and purse seiners (fleet C), while Subdivisions 22–24 have directed trawl, gillnet, and trapnet fisheries (fleet F). The herring by-catches taken in Division IIIa in the small mesh trawl fishery for Norway pout, sandeel, and sprat (fleet D) are mainly autumn spawners from the North Sea stock. After a period of high landings in the early 1980s the combined landings of all fleets have decreased to below the long-term average.

The TACs in Division IIIa in 2001 were: 1) for the directed fishery 80 000 t, and 2) for by-catch in the small mesh fisheries 21 000 t. The TAC comprises both the autumn- and spring-spawning stocks in the area. The spring spawners are also fished in the Baltic, under the overall IBSFC herring TAC of 300 000 t (Subdivisions 22–32). The TACs in Div. IIIa for 2002 are 80 000 t for directed fishery and a total of 21 000 t for by-catches in the small mesh fisheries.

The otolith microstructure method to calculate the proportion of spring and autumn spawners caught in these areas has been implemented, all catch and IBTS data for the period 1991–1999 has been revised. Continued development of the stock identification methods should be applied to explore the importance of local stock components in the area.

Analytical assessment is based on catch data and acoustic and trawl survey results. In order to continue to improve the assessment, a comprehensive survey covering the whole stock is needed.

Source of information: Report of the Herring Assessment Working Group for the Area South of 62°N, March 2002 (ICES CM 2002/ACFM:12).

Yield and spawning biomass per Recruit F-reference points:

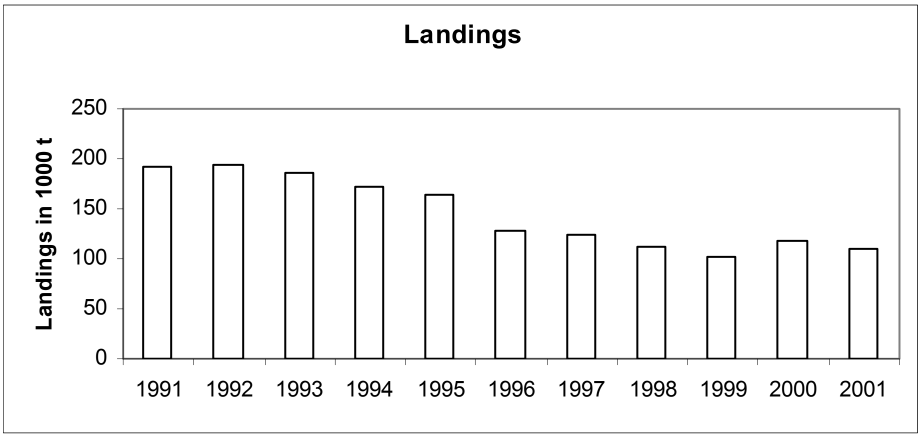
	Fish Mort Ages 3–6	Yield/R	SSB/R
Average Current	0.498	0.024	0.030
$\mathbf{F}_{max}$	0.372	0.024	0.046
$\mathbf{F}_{0.1}$	0.202	0.022	0.089
$\mathbf{F}_{med}$	N/A		

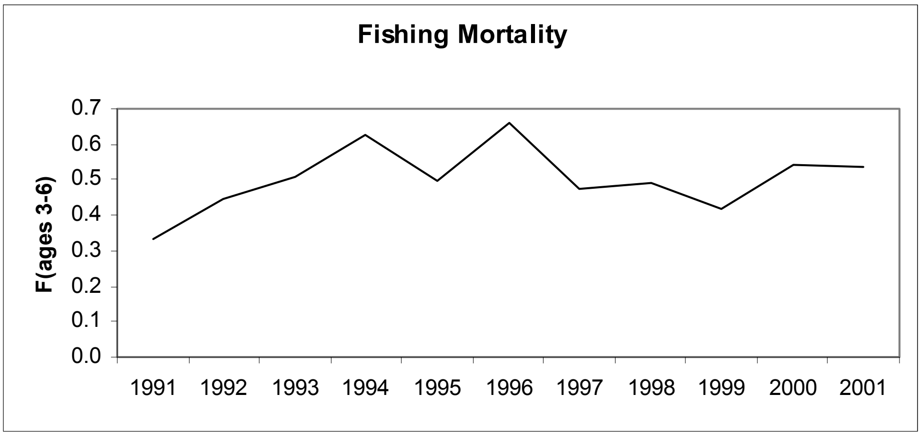
Catch data: (Tables 3.14.3.1–2)

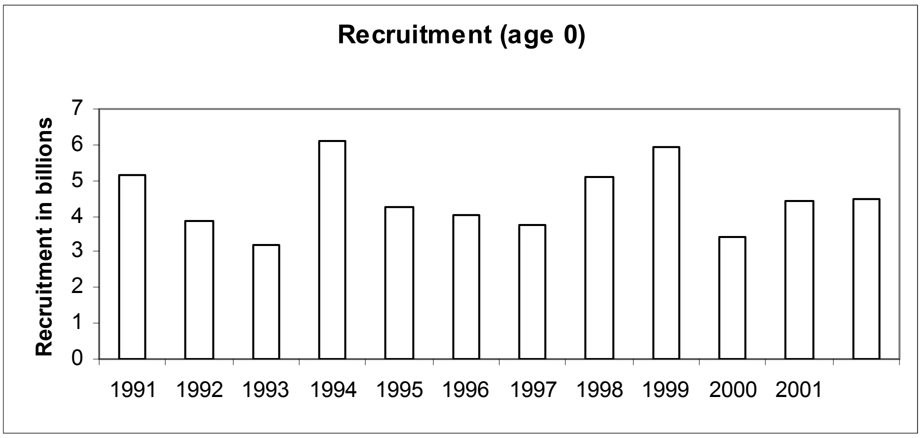
Year	ICES Advice	Pred. Catch Corresp. to advice	Agreed TAC	ACFM catch of Stock			
				22–24	IIIa	IV	Total
1987	Reduction in F	224		102	59	14	175
1988	No increase in F	196		99	129	23	251
1989	TAC	174		95	71	20	186
1990	TAC	131		78	118	8	204
1991	TAC	180		70	112	10	192
1992	TAC	180		85	101	9	195
1993	Increased yield from reduction in F; reduction in juvenile catches	188		81	95	10	186
1994	TAC	130–180		66	92	14	172
1995	If required, TAC not exceeding recent catches	168–192		74	80	10	164
1996	If required, TAC not exceeding recent catches	164–171		58	71	1	130
1997	IIIa: managed together with autumn-spawners 22–24: if required, TAC not exceeding recent catches	66–85[1]		68	55	1	124
1998	Should be managed in accordance with North Sea autumn spawners	-		51	53	8	112
1999	IIIa: managed together with autumn spawners 22–24: if required, TAC not exceeding recent catches	-		50	43	5	98
2000	IIIa: managed together with autumn spawners 22–24: if required, TAC not exceeding recent catches	~60 for Sub-divs. 22–24		54	57	7	118
2001	IIIa: managed together with autumn spawners 22–24: if required, TAC not exceeding recent catches	~50 for Sub-divs. 22–24		62	42	6	110
2002	IIIa: managed together with autumn spawners 22–24: if required, TAC not exceeding recent catches	~50 for Sub-divs. 22–24					
2003	Decrease F	<80					

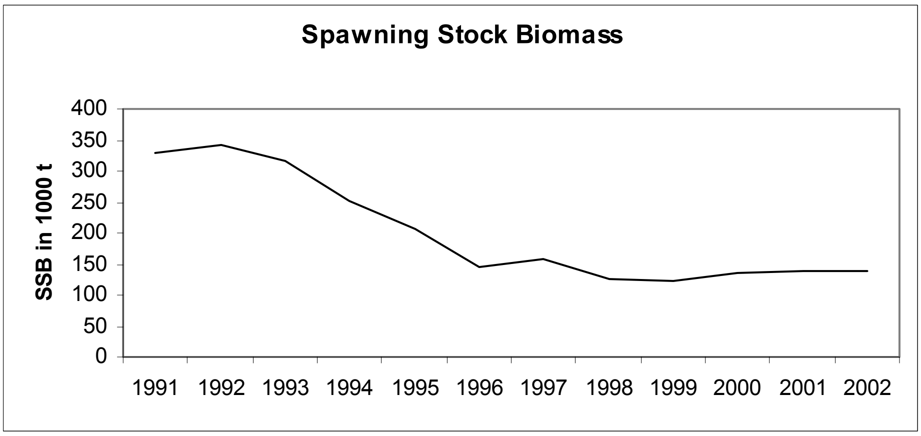
[1]Catch in Subdivisions 22–24. Weights in '000 t.

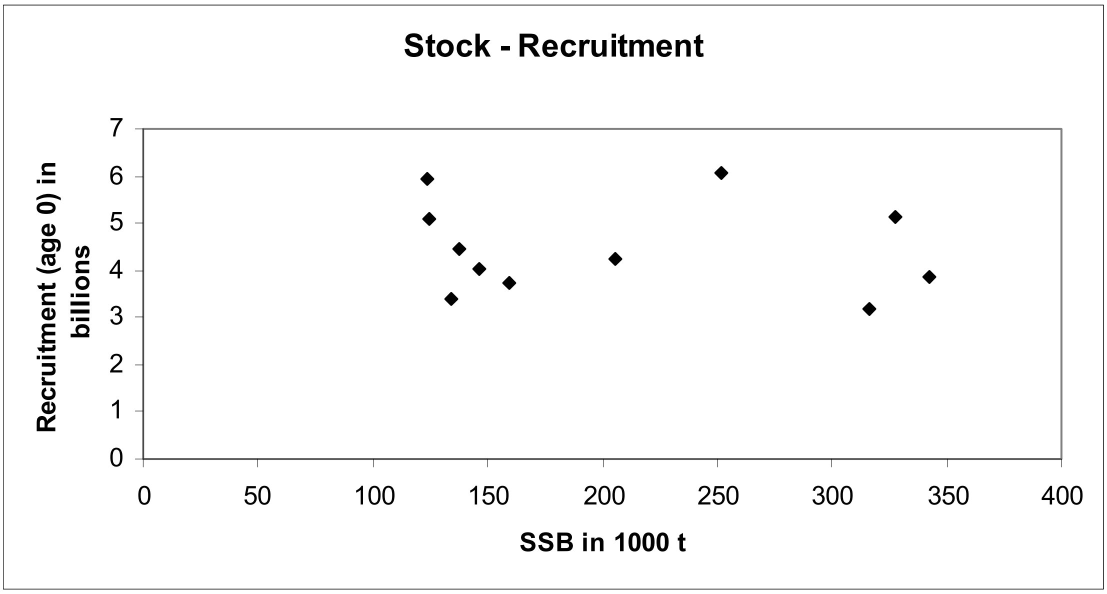
Herring in Subdivisions 22–24 and Division IIIa (spring-spawners)










Stock - Recruitment
Recruitment (age 0) in billions
SSB in 1000 t
0
1
2
3
4
5
6
7
0
50
100
150
200
250
300
350
400

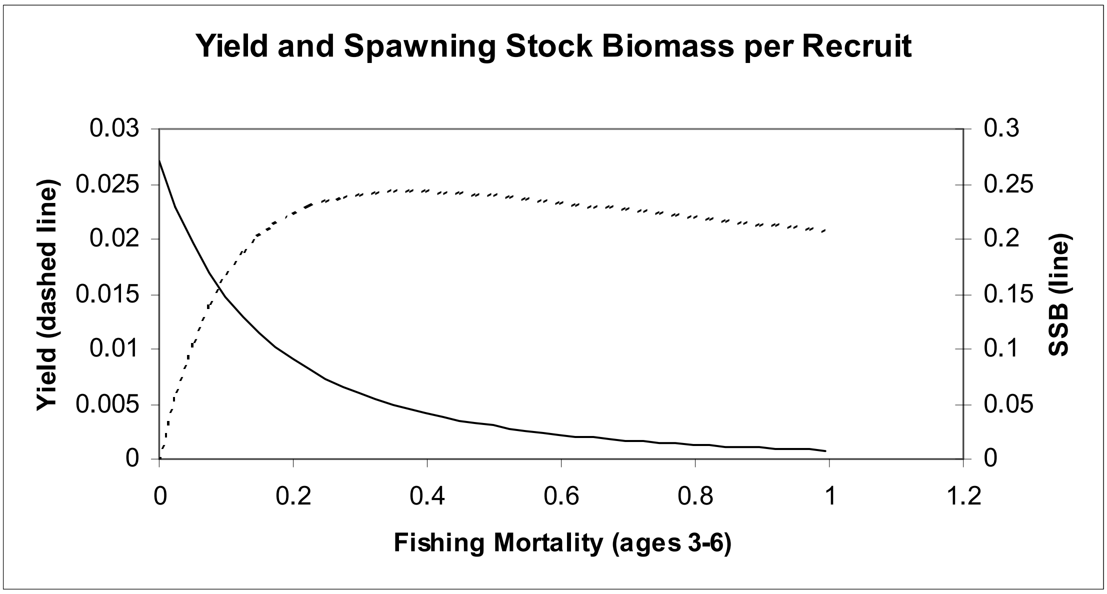

Yield and Spawning Stock Biomass per Recruit
Yield (dashed line)
SSB (line)
Fishing Mortality (ages 3-6)
0
0.005
0.01
0.015
0.02
0.025
0.03
0
0.05
0.1
0.15
0.2
0.25
0.3
0
0.2
0.4
0.6
0.8
1
1.2

Table 3.14.3.1 HERRING in Division IIIa and Subdivisions 22–24. 1985–2001. Landings in thousands of tonnes. Autumn and spring spawners in Division IIIa. (Data provided by Working Group members 2001).

Year	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Skagerrak										
Denmark	88.2	94.0	105.0	144.4	47.4	62.3	58.7	64.7	87.8	44.9
Faroe Islands	0.5	0.5								
Norway	4.5	1.6	1.2	5.7	1.6	5.6	8.1	13.9	24.2	17.7
Sweden	40.3	43.0	51.2	57.2	47.9	56.5	54.7	88.0	56.4	66.4
Total	133.5	139.1	157.4	207.3	96.9	124.4	121.5	166.6	168.4	129.0
Kattegat										
Denmark	69.2	37.4	46.6	76.2	57.1	32.2	29.7	33.5	28.7	23.6
Sweden	39.8	35.9	29.8	49.7	37.9	45.2	36.7	26.4	16.7	15.4
Total	109.0	73.3	76.4	125.9	95.0	77.4	66.4	59.9	45.4	39.0
Sub. Div. 22+24										
Denmark	15.9	14.0	32.5	33.1	21.7	13.6	25.2	26.9	38.0	39.5
Germany	54.6	60.0	53.1	54.7	56.4	45.5	15.8	15.6	11.1	11.4
Poland	16.7	12.3	8.0	6.6	8.5	9.7	5.6	15.5	11.8	6.3
Sweden	11.4	5.9	7.8	4.6	6.3	8.1	19.3	22.3	16.2	7.4
Total	98.6	92.2	101.4	99.0	92.9	76.9	65.9	80.3	77.1	64.6
Sub. Div. 23										
Denmark	6.8	1.5	0.8	0.1	1.5	1.1	1.7	2.9	3.3	1.5
Sweden	1.1	1.4	0.2	0.1	0.1	0.1	2.3	1.7	0.7	0.3
Total	7.9	2.9	1.0	0.2	1.6	1.2	4.0	4.6	4.0	1.8
Grand Total	349.0	307.5	336.2	432.4	286.4	279.9	257.8	311.4	294.9	234.4

Year	1995	1996	1997	1998	1999	2000	2001[1]
Skagerrak							
Denmark	43.7	28.7	14.3	10.3	10.1	16.0	16.2
Faroe Islands							
Norway	16.7	9.4	8.8	8.0	7.4	9.7	8.3
Sweden	48.5	32.7	32.9	46.9	36.4	45.8	30.8
Total	108.9	70.8	56.0	65.2	53.9	71.5	55.3
Kattegat							
Denmark	16.9	17.2	8.8	23.7	17.9	18.9	18.8
Sweden	30.8	27.0	18.0	29.9	14.6	17.3	16.2
Total	47.7	44.2	26.8	53.6	32.5	36.2	35.0
Sub. Div. 22+24							
Denmark	36.8	34.4	30.5	30.1	32.5	32.6	28.3
Germany	13.4	7.3	12.8	9.0	9.8	9.3	9.9
Poland	7.3	6.0	6.9	6.5	5.3	6.6	9.3
Sweden	15.8	9.0	14.5	4.3	2.6	4.8	13.9
Total	73.3	56.7	64.7	49.9	50.2	53.3	61.4
Sub. Div. 23							
Denmark	0.9	0.7	2.2	0.4	0.5	0.9	0.6
Sweden	0.2	0.3	0.1	0.3	0.1	0.1	0.2
Total	1.1	1.0	2.3	0.7	0.6	1.0	0.8
Grand Total	231.0	172.7	149.8	169.4	137.2	162.0	152.5

[1] Preliminary.

Table 3.14.3.2 Herring in Subdivisions 22–24 and Division IIIa (spring spawners).

Year	Recruitment Age 0 thousands	SSB Tonnes	Landings tonnes	Mean F Ages 3–6
1991	5152960	327477	191573	0.3358
1992	3870880	342905	194411	0.4441
1993	3167210	316405	185010	0.5061
1994	6087790	251977	172438	0.6243
1995	4260820	205460	164284	0.4942
1996	4014880	146638	128243	0.6621
1997	3749770	159142	123199	0.4738
1998	5080980	124774	112386	0.4905
1999	5928180	123367	101573	0.4161
2000	3393080	134518	118278	0.5416
2001	4446510	137931	110192	0.5351
2002	4490961	139690		
Average	4470335	200857	145599	0.5022

3.14.4 Central Baltic Herring (Subdivisions 25–29 (including Gulf of Riga) and 32)

The best way to assess the herring in Subdivisions 25-29 and 32 has been reviewed once more. The information on the various stock components or spawning types of herring is still insufficient to make a total revision of the assessment structure (see section on research programme in this report). However, available information indicate that the Gulf herring in Gulf of Riga can be treated as a separate stock. These herring can be separated in the catches and the stock shows a clearly different pattern in recruitment and in stock size development.

Therefore, ICES decided to provide separate advice for the herring in Central Baltic (Subdivisions 25-29, 32 exclusive Gulf of Riga herring) and for the Gulf herring in the Gulf of Riga. As requested by IBSFC ICES presents assessments and catch options for the following stock components: combined in Subdivisions 25-29+32 (excluding Gulf of Riga herring), see Section 3.14.4.a; the Gulf of Riga herring for the stock, see Section 3.14.4.b; and combined in Subdivisions 25-29+32 (including Gulf of Riga herring), see Section 3.14.4.c.

ICES recommends that the herring in the Baltic should be managed according to stock, i.e:

Herring Unit	**Proposed Management Area**
Herring in Subdivisions 22-24	South-western Baltic, Subdivisions 22,23,24
Central Baltic Herring	Subdivisions 25, 26, 27, 28, 29 and 32 (excl. Gulf of Riga)
Gulf of Riga herring	Gulf of Riga (part of Subdivision 28)
Herring in Subdivision 30	Bothnian Sea (Subdivision 30)
Herring in Subdivision 31	Bothnian Bay (Subdivision 31).

Table 3.14.4.1 Herring catches in Subdivisions 25-29, 32 (thousand tonnes).

Year	Denmark	Estonia	Finland	Germany	Latvia	Lithuania	Poland	Russia[1)]	Sweden	Total
1977	11.9		33.7	0.0			57.2	137.0	48.7	313.7
1978	13.9		38.3	0.1			61.3	130.6	55.4	305.2
1979	19.4		40.4	0.0			70.4	118.1	71.3	323.1
1980	10.6		44.0	0.0			58.3	118.0	72.5	304.4
1981	14.1		42.5	1.0			51.2	110.2	72.9	294.0
1982	15.3		47.5	1.3			63.0	99.2	83.8	311.1
1983	10.5		59.1	1.0			67.1	84.6	78.6	302.0
1984	6.5		54.1	0.0			65.8	105.6	56.9	289.9
1985	7.6		54.2	0.0			72.8	110.8	42.5	289.5
1986	3.9		49.4	0.0			67.8	115.7	29.7	268.3
1987	4.2		50.4	0.0			55.5	113.8	25.4	251.9
1988	10.8		58.1	0.0			57.2	122.8	33.4	286.3
1989	7.3		50.0	0.0			51.8	121.8	55.4	289.9
1990	4.6		26.9	0.0			52.3	116.2	44.2	244.2
1991	6.8	32.7	18.1	0.0	33.3	6.5	47.1	31.9	36.5	212.8
1992	8.1	29.7	30.0	0.0	25.8	4.6	39.2	29.5	43.0	209.9
1993	8.9	32.7	32.3	0.0	25.4	3.0	41.1	21.6	66.4	231.4
1994	11.3	33.7	38.2	3.7	26.2	4.9	46.1	16.7	61.6	242.4
1995	11.4	42.9	31.4	0.0	28.4	3.6	38.7	17.0	47.2	220.6
1996	12.1	44.9	31.5	0.0	31.0	4.2	30.7	14.6	25.9	195.1
1997	9.4	54.7	23.7	0.0	33.8	3.3	26.2	12.5	44.1	207.8
1998	13.9	42.9	24.8	0.0	27.6	2.4	19.3	10.5	71.0	212.4
1999	6.2	43.1	17.9	0.0	30.2	1.3	18.1	12.7	48.9	178.3
2000	15.8	39.7	23.2	0.0	30.0	1.1	23.1	14.8	60.2	207.8
2001*	15.8	40.2	26.1	0.0	30.1	1.6	28.4	15.8	29.8	187.8

* Preliminary.
[1)] In 1977-1990 sum of catches by Estonia, Latvia, Lithuania, and Russia

3.14.4.a Herring in Subdivisions 25–29 and 32 (excluding Gulf of Riga herring)

State of stock/exploitation: Although the exact stock size is uncertain, there is high confidence that the spawning biomass is close to the historic low. The fishing mortality increased throughout the late 1990s and the stock is currently harvested outside safe biological limits. Current fishing mortality is above $\mathbf{F}_{pa}$ and even above $\mathbf{F}_{lim}$.

Management objectives: There are no explicit management objectives for this stock. However, for any management objective to meet the precautionary criteria, F should be less than the proposed $\mathbf{F}_{pa}$ and spawning stock biomass should be maintained above $\mathbf{B}_{pa}$ once an appropriate value is identified.

Precautionary Approach reference points (proposed in 2002):

ICES considers that:	ICES proposes that:
$\mathbf{B}_{lim}$ not defined	$\mathbf{B}_{pa}$ not defined
$\mathbf{F}_{lim}$ is 0.33	$\mathbf{F}_{pa}$ be set at 0.19

Technical basis:

$\mathbf{B}_{lim}$ not defined	$\mathbf{B}_{pa}$ not defined
$\mathbf{F}_{lim}$: $\mathbf{F}_{loss}$	$\mathbf{F}_{pa}$: $\mathbf{F}_{med}$

There is no biological basis at present for determining biomass reference points.

Advice on management: ICES recommends that fishing mortality in 2003 should be reduced below the $\mathbf{F}_{pa}$ = 0.19 to allow the SSB to increase, corresponding to a catch of less than 72 000 t.

Relevant factors to be considered in management: The TAC for herring in the Central Baltic has been kept far above the reported landings since 1989. Herring and sprat are mostly caught in mixed fisheries, but directed fisheries exist in some countries.

The implication of a substantially reduced harvest of the herring stock as advised should be considered when implementing the management plan for sprat fisheries.

Catch forecast for 2003:

Basis: F(2002) =$\mathbf{F}_{sq}$= F(1999–2001) =0.4333; Landings(2002) =148; SSB(2002) =362.

F(2003)	Basis	SSB(2003)	Landings (2003)	SSB (2004)
0.00	0.0	416	0	560
0.043	0.1*$\mathbf{F}_{sq}$	411	17	537
0.087	0.2*$\mathbf{F}_{sq}$	406	34	515
0.130	0.3*$\mathbf{F}_{sq}$	401	51	494
0.173	0.4*$\mathbf{F}_{sq}$	396	66	474
0.19	0.44*$\mathbf{F}_{sq}$ ($\mathbf{F}_{pa}$)	394	72	467
0.217	0.5*$\mathbf{F}_{sq}$	391	82	455
0.260	$\mathbf{F}_{0.1}$	386	86	436
0.347	0.8*$\mathbf{F}_{sq}$	376	124	402
0.433	$\mathbf{F}_{sq}$	367	151	371

Weights in '000 t.

Shaded scenario considered inconsistent with the precautionary approach.

Comparison with previous assessment and advice: The present assessment gives 4% lower estimate of SSB(1999) and 2% higher fishing mortality (1999) than the assessment performed two years ago.

Medium- and long-term projections: Medium-term predictions given in Figure 3.14.4.a.1, are based on the assumption of a 25% reduction in F for year 2002. The fishing mortality is kept at 0.4*$\mathbf{F}_{sq}$ = 0.17, which is below $\mathbf{F}_{pa}$ for the remaining years 2003-2010. The results show a slow increase in SSB to slightly above 400 000 t in the medium-term. After an initial decrease in landings in the short term to just above 70 000 t, landings will stabilise around 100 000 t in the medium-term.

Elaboration and special comment: The assessment is uncertain, due to the complexity of the stock structure and the uncertain split between herring and sprat in most pelagic fisheries in the area.

Much of the estimated decline in SSB has been attributed to the overall decrease in mean weights-at-age, as the numbers of mature herring (spawning stock in numbers) have remained stable during 1986–1996. The decrease in SSB since 1997 has, however, been associated with a marked decline in numbers.

The decrease of the stock could be connected with the reproduction decline in the last 15 years. The recruitment has been mainly low and occasionally average since 1986. However, no information on a worsening situation on the spawning grounds or on unfavourable feeding conditions for herring larvae is available.

Source of information: Report of the Baltic Fisheries Assessment Working Group, 15 – 24 April 2002 (ICES CM 2002/ACFM:17).

Yield and spawning biomass per Recruit F-reference points:

	Fish Mort Ages 3-6	Yield/R	SSB/R
Average Current	0.433	0.011	0.028
$\mathbf{F}_{max}$	1.582	0.012	0.007
$\mathbf{F}_{0.1}$	0.258	0.010	0.041
$\mathbf{F}_{med}$	0.189	0.009	0.051

Catch data :

Year	ICES Advice 1987-2002 incl. Gulf of Riga herring	Predicted catch Corresp. to advice	Agreed TAC[1]	ACFM Catch 22–24	25–29+32	Total
1987		200	399	102	252	354
1988		204	399	99	286	385
1989		176	399	95	290	385
1990		112	399	78	244	322
1991	TAC for entire area	293	402	70	213	283
1992	F near present level	343	402	85	210	295
1993	Increase in yield at higher F	371	560	81	231	312
1994	Increase in yield at higher F	317–463	560	66	242	308
1995	TAC	394	560	74	221	295
1996	TAC	394	560	58	195	253
1997	No advice	-	560	68	208	276
1998	No advice	-	560	51	212	263
1999	Proposed $\mathbf{F}_{pa} =$ (0.17)	117	476	50	178	228
2000	Proposed $\mathbf{F}_{pa} =$ (0.17)	95	405	54	208	262
2001	Proposed $\mathbf{F}_{pa} =$ (0.17)	60	300	62	188	250
2002	$< \mathbf{F}_{pa}$	73	No agreed			
2003	$< \mathbf{F}_{pa}$	72				

[1] TAC is for Subdivisions 22–29, 32. Weights in '000 t.

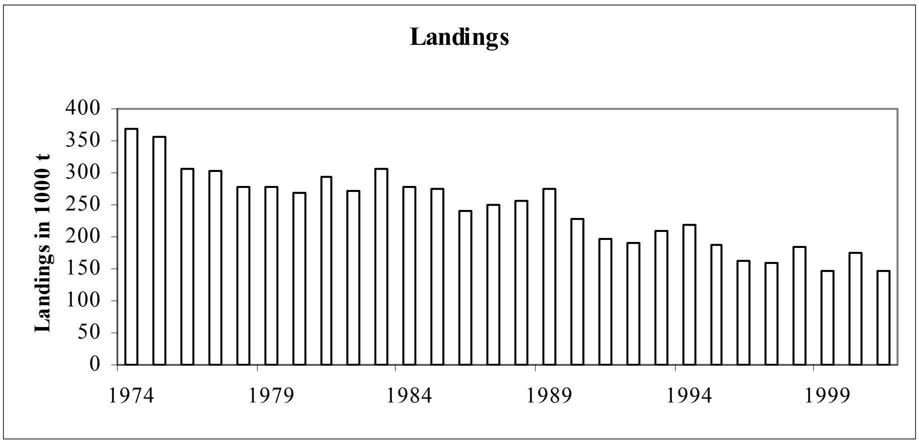
Table 13.14.4.a.1 Herring catches ('000 t) in Subdivisions 25-29 and 32 excl. Gulf of Riga herring but incl. catches of open-sea herring in the Gulf of Riga.

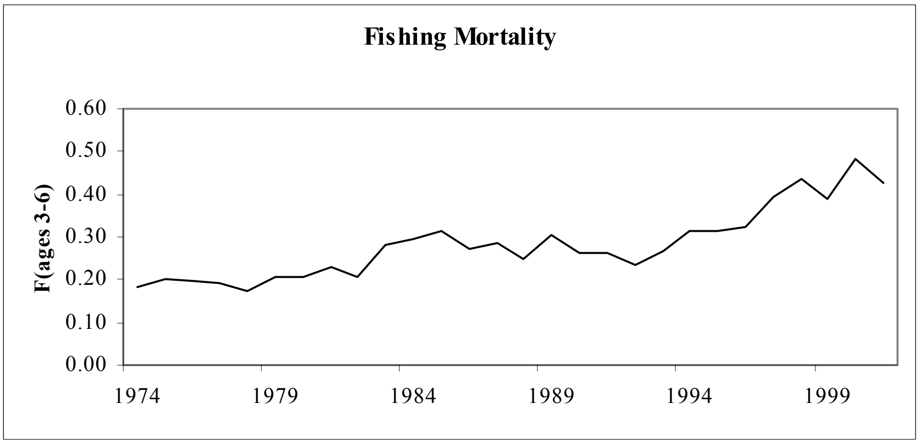
Year	Denmark	Estonia	Finland	Germany	Latvia	Lithuania	Poland	Russia**	Sweden	Total
1977	11.9		33.7	0.0			57.2	112.8	48.7	264.3
1978	13.9		38.3	0.1			61.3	113.9	55.4	282.9
1979	19.4		40.4	0.0			70.4	101.0	71.3	302.5
1980	10.6		44.0	0.0			58.3	103.0	72.5	288.4
1981	14.1		42.5	1.0			51.2	93.4	72.9	275.1
1982	15.3		47.5	1.3			63.0	86.4	83.8	297.3
1983	10.5		59.1	1.0			67.1	69.1	78.6	285.4
1984	6.5		54.1	0.0			65.8	89.8	56.9	273.1
1985	7.6		54.2	0.0			72.8	95.2	42.5	272.3
1986	3.9		49.4	0.0			67.8	98.8	29.7	249.6
1987	4.2		50.4	0.0			55.5	100.9	25.4	236.4
1988	10.8		58.1	0.0			57.2	106.0	33.4	265.5
1989	7.3		50.0	0.0			51.8	105.0	55.4	269.5
1990	4.6		26.9	0.0			52.3	101.4	44.2	229.4
1991	6.8	29.7	18.1	0.0	21.5	6.5	47.1	31.9	36.5	198.1
1992	8.1	22.4	30.0	0.0	11.6	4.6	39.2	29.5	43.0	188.4
1993	8.9	25.3	32.3	0.0	9.3	3.0	41.1	21.6	66.4	207.9
1994	11.3	28.2	38.2	3.7	7.4	4.9	46.1	16.7	61.6	218.1
1995	11.4	30.8	31.4	0.0	7.8	3.6	38.7	17.0	47.2	187.9
1996	12.1	35.8	31.5	0.0	7.6	4.2	30.7	14.6	25.9	162.4
1997	9.4	41.7	23.7	0.0	6.8	3.3	26.2	12.5	44.1	167.7
1998	13.9	34.0	24.8	0.0	7.1	2.4	19.3	10.5	71.0	183.0
1999	6.2	35.5	17.9	0.0	6.4	1.3	18.1	12.7	48.9	147.0
2000	15.8	30.1	23.3	0.0	5.5	1.1	23.1	14.8	60.2	173.9
2001	15.8	27.4	26.1	0.0	4.1	1.6	28.4	15.8	29.8	149.0

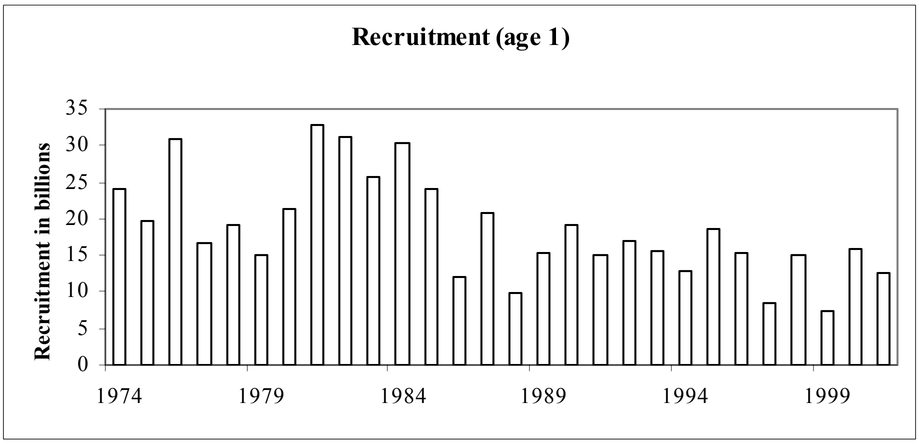
* preliminary

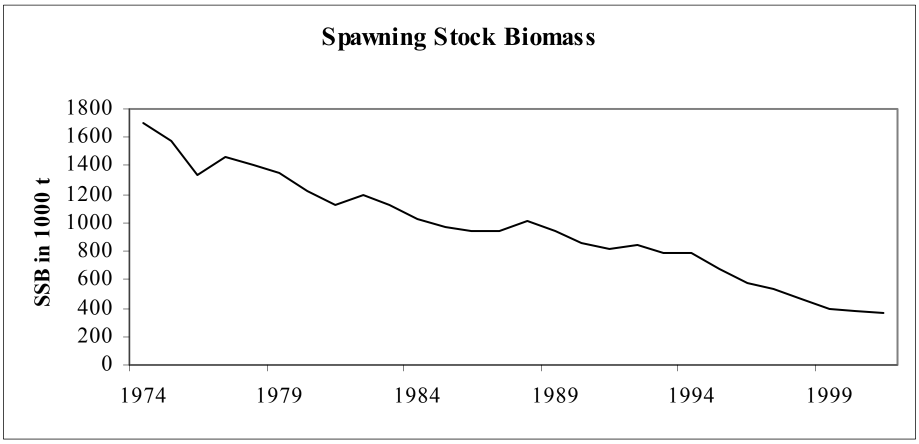
** in 1977-1990 sum of catches by Estonia, Latvia, Lithuania, and Russia

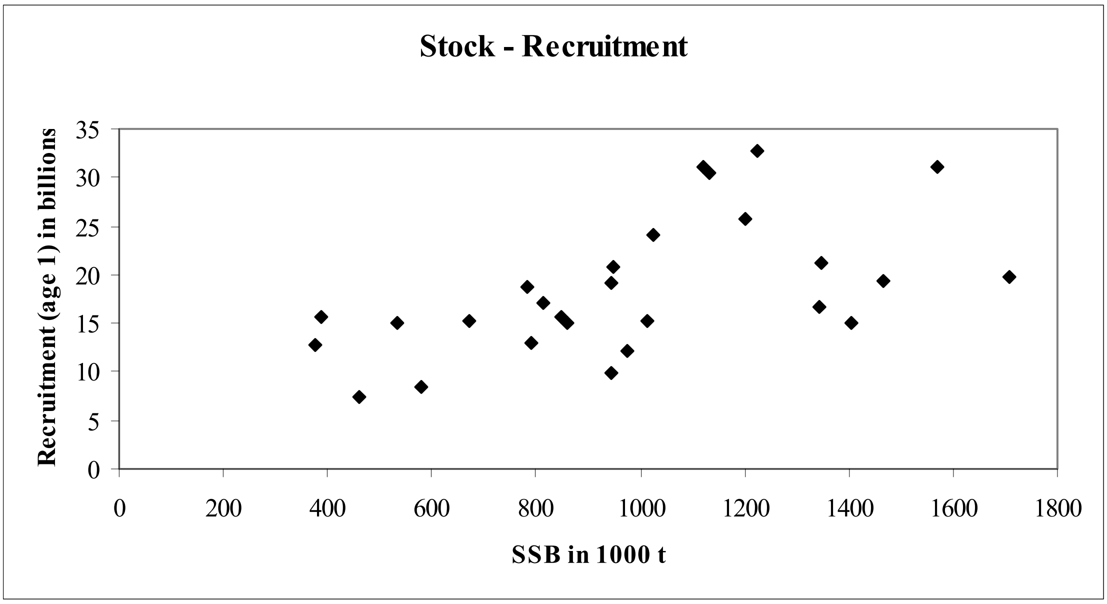
Herring in Subdivisions 25 to 29 and 32 excluding Gulf of Riga

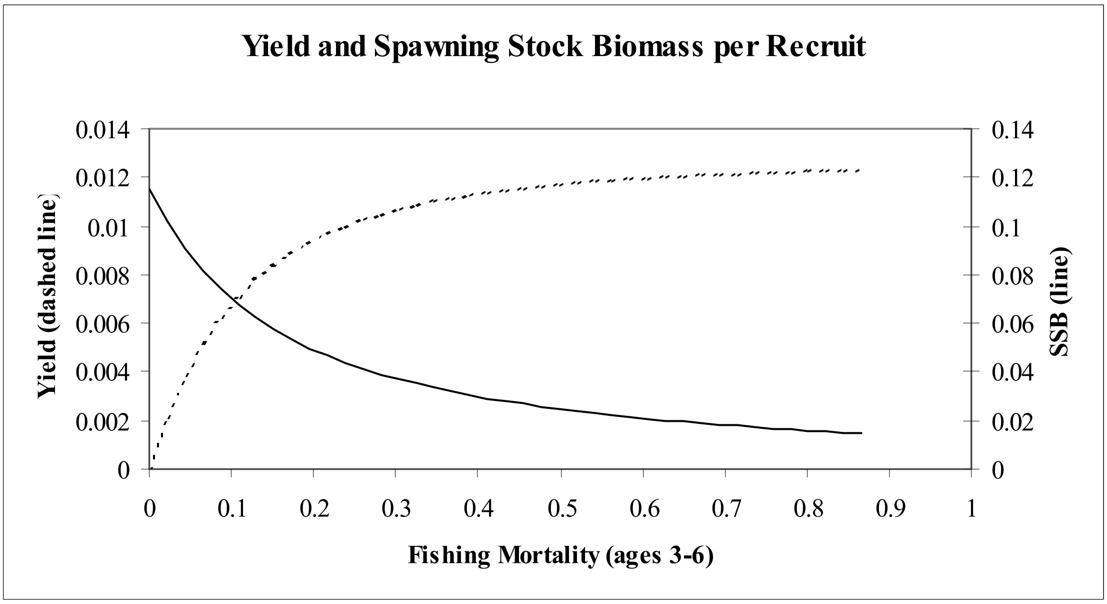









Stock - Recruitment
Recruitment (age 1) in billions
SSB in 1000 t
0
5
10
15
20
25
30
35
0
200
400
600
800
1000
1200
1400
1600
1800


Yield and Spawning Stock Biomass per Recruit
Yield (dashed line)
SSB (line)
Fishing Mortality (ages 3-6)
0
0.002
0.004
0.006
0.008
0.01
0.012
0.014
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

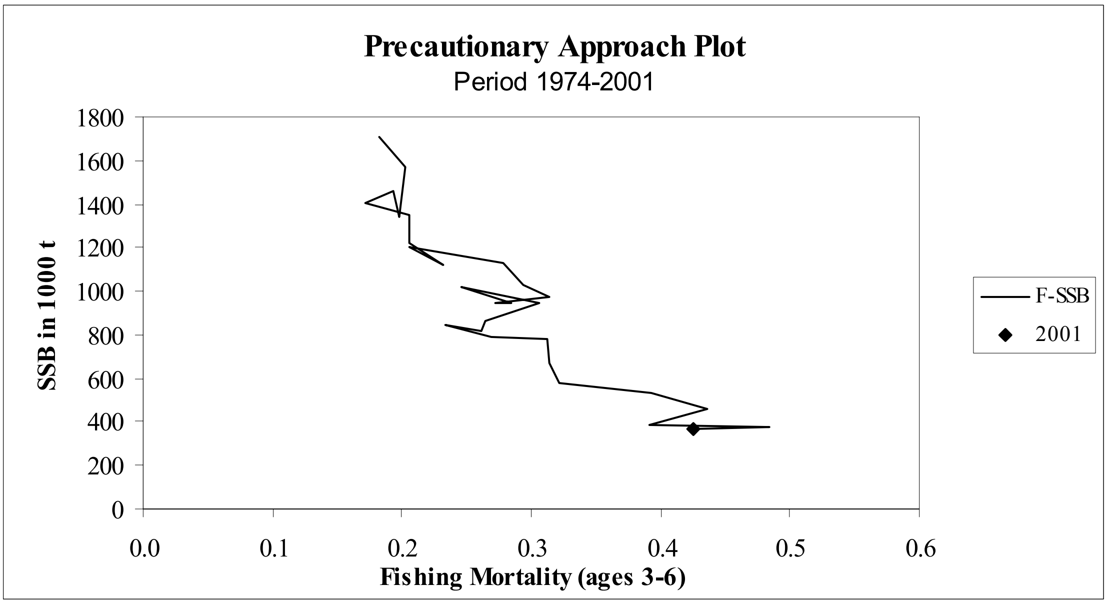

Precautionary Approach Plot
Period 1974-2001
SSB in 1000 t
Fishing Mortality (ages 3-6)
F-SSB
2001
0
200
400
600
800
1000
1200
1400
1600
1800
0.0
0.1
0.2
0.3
0.4
0.5
0.6

Table 3.14.4.a.2 Herring in Subdivisions 25 to 29 and 32 excl. Gulf of Riga.

Year	Recruitment Age 1 thousands	SSB tonnes	Landings tonnes	Mean F Ages 3-6
1974	24048128	1707089	368652	0.1828
1975	19814050	1570917	354851	0.2023
1976	31014348	1342492	305420	0.1982
1977	16666728	1464260	301952	0.1937
1978	19273218	1404393	278966	0.1715
1979	14943418	1347676	278182	0.2049
1980	21221916	1225202	270282	0.2060
1981	32777548	1119343	293615	0.2312
1982	31152340	1199368	273134	0.2051
1983	25709262	1130397	307601	0.2791
1984	30424876	1024608	277926	0.2945
1985	24012544	974228	275760	0.3145
1986	12065035	948179	240516	0.2724
1987	20699780	944231	248653	0.2840
1988	9864868	1015054	255734	0.2464
1989	15199737	943707	275501	0.3055
1990	19080818	859572	228572	0.2643
1991	15083874	814420	197676	0.2620
1992	17082376	849193	189781	0.2330
1993	15595961	790635	209094	0.2695
1994	12917901	784857	218260	0.3130
1995	18707596	671108	188181	0.3138
1996	15302025	578652	162578	0.3221
1997	8408537	534446	160002	0.3921
1998	15019580	459148	185780	0.4358
1999	7339230	387855	145922	0.3909
2000	15730943	377248	175646	0.4835
2001	12668111	368023	148404	0.4253
Average	18636598	958439	243451	0.2821

g

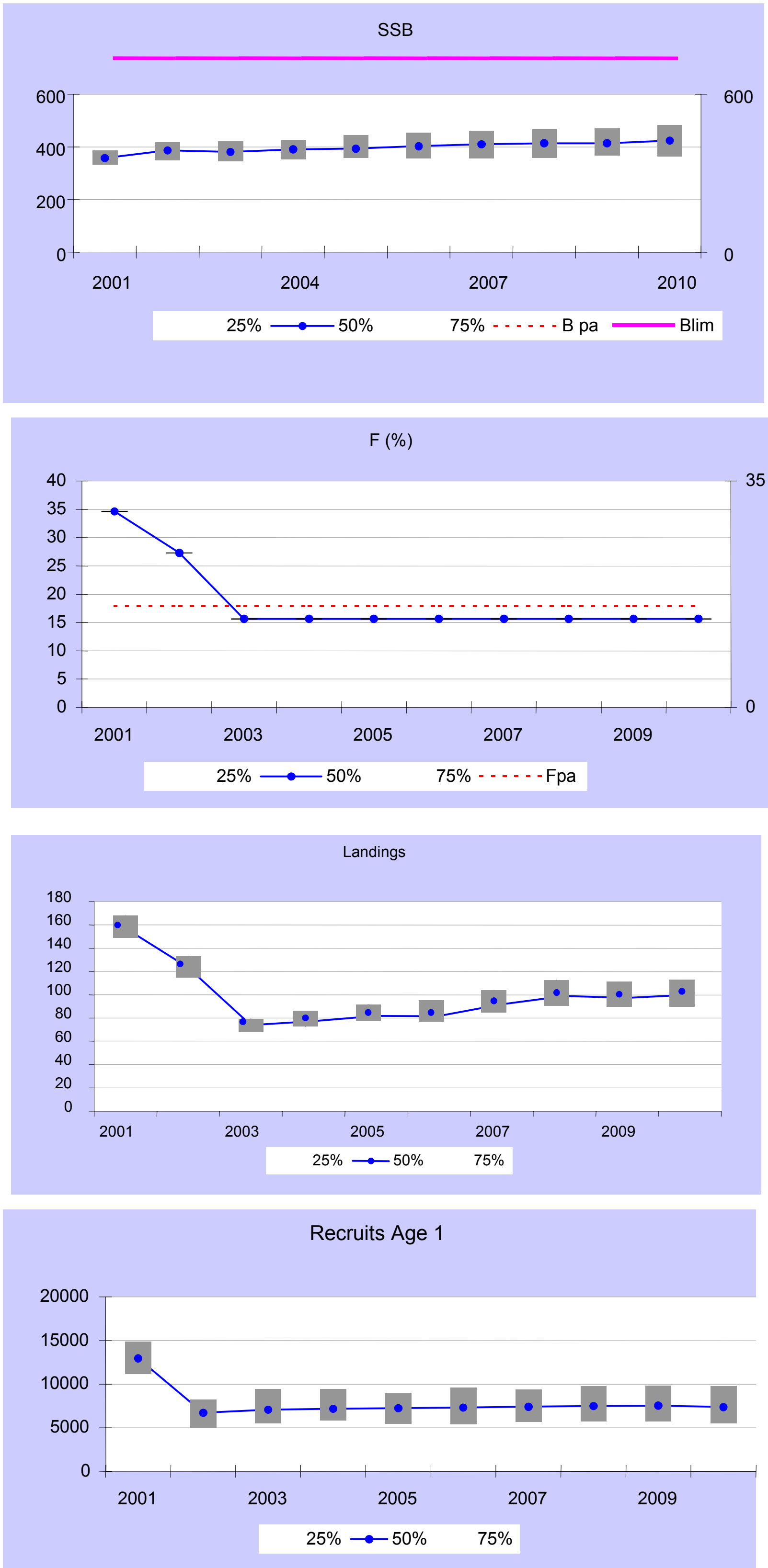


Figure 3.14.4.a.1 Herring in 25-29, 32 excl. GoRiga. Medium-term projections assuming $\mathbf{F_{pa}}$ from 2003

3.14.4.b Herring in the Gulf of Riga

State of stock/exploitation: The stock is within safe biological limits. SSB and recruitment have been high since 1990, with the exception of the 1996 year class. Fishing mortality was below $\mathbf{F}_{pa}$ during the 1990s, except for 1997–1998.

Management objectives: There are no explicit management objectives for this stock. However, for any management objective to meet the precautionary criteria, F should be less than the $\mathbf{F}_{pa}$ and spawning stock biomass should be maintained above the $\mathbf{B}_{pa}$.

Precautionary Approach reference points (proposed in 1999):

ICES considers that:	ICES proposes that:
$\mathbf{B}_{lim}$ is 36 500 t	$\mathbf{B}_{pa}$ be set at 50 000 t
$\mathbf{F}_{lim}$ not defined	$\mathbf{F}_{pa}$ be set at 0.4

Technical basis:

$\mathbf{B}_{lim}$: $\mathbf{B}_{pa}$/exp (1.65*0.2)	$\mathbf{B}_{pa}$: = MBAL=50 000 t
$\mathbf{F}_{lim}$: not defined	$\mathbf{F}_{pa}$: from medium-term projections

Advice on management: ICES recommends that fishing mortality should be kept below $\mathbf{F}_{pa}$, corresponding to catches of less than 41 000 t.

Catch forecast for 2003:

Basis: F(2002) = $\mathbf{F}_{sq}$ = F(1999-2001) = 0.28; Landings(2002) = 31 ; SSB(2002) = 121.

F (2003)	Basis	SSB (2003)	Catch (2003)	SSB (2004)	Medium-term effect of fishing at given level
0.23	0.8*$\mathbf{F}_{sq}$	129	25.2	125	Slow increase of SSB
0.28	$\mathbf{F}_{sq}$	128	31.0	119	Stable SSB
0.34	1.2* $\mathbf{F}_{sq}$	125	36.1	113	Stable SSB
0.39	1.4*$\mathbf{F}_{sq}$($\mathbf{F}_{pa}$)	124	41.0	107	Slow decrease of SSB
0.45	1.6*$\mathbf{F}_{sq}$	123	46.0	102	Decrease of SSB

Weights in '000 t.

Shaded scenarios considered inconsistent with the precautionary approach

Relevant factors to be considered in management: Management measures for Gulf of Riga herring should take into account that approximately 7% of the herring is taken outside the Gulf of Riga and approximately 12% of the catches in the Gulf of Riga consist open-sea herring from the Main Basin. In 2001 the catch of open-sea herring in the Gulf of Riga was approximately 3 000 t.

Comparison with previous assessment and advice: The present assessment gives 4% higher estimates of SSB(2000) and 3% lower estimate of F(2000) than last year's assessment.

Elaboration and special comment: Herring catches in the Gulf of Riga include both Gulf herring and open-sea herring, which enter the Gulf of Riga from April to June for spawning. The herring in the Gulf of Riga is fished by Estonia and Latvia. The structure of the fishery has remained unchanged in recent decades: approximately 70% of the catches are taken by the trawl fishery and 30% by the trapnet fishery on the spawning grounds.

Analytical assessment is based on catch data and trapnet CPUE series. Gulf of Riga herring is separated in the landings by means of otolith structure.

Source of information: Report of the Baltic Fisheries Assessment Working Group, 15-24 April 2002 (ICES CM 2002/ACFM:17).

Yield and spawning biomass per Recruit
F-reference points:

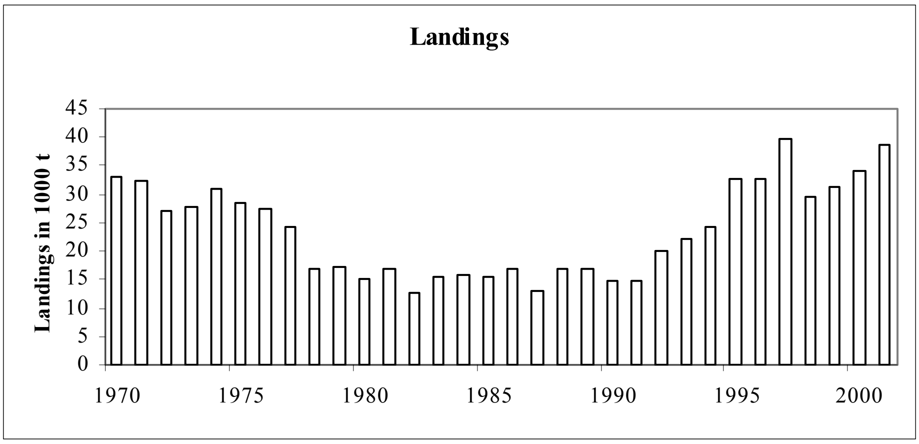
	Fish Mort Ages 3-7	Yield/R	SSB/R
Average Current	0.323	0.010	0.035
$\mathbf{F}_{max}$	1.548	0.012	0.008
$\mathbf{F}_{0.1}$	0.265	0.009	0.040
$\mathbf{F}_{med}$	0.377	0.010	0.032

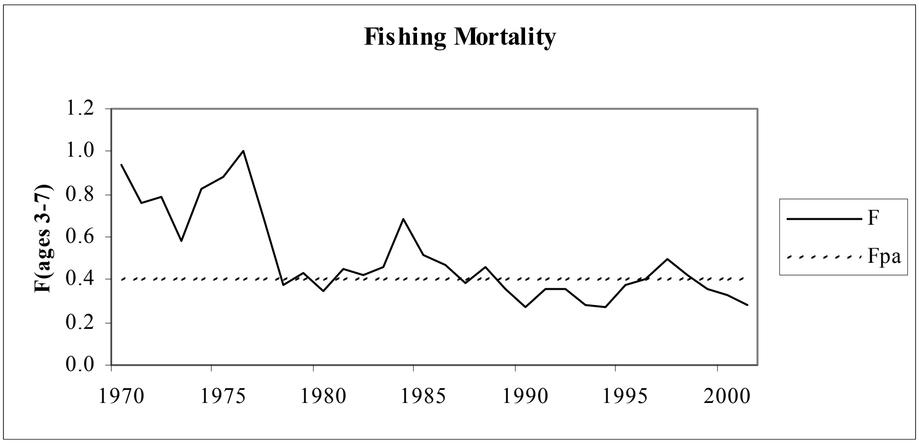
Catch data (Tables 3.14.4.b.1-3):

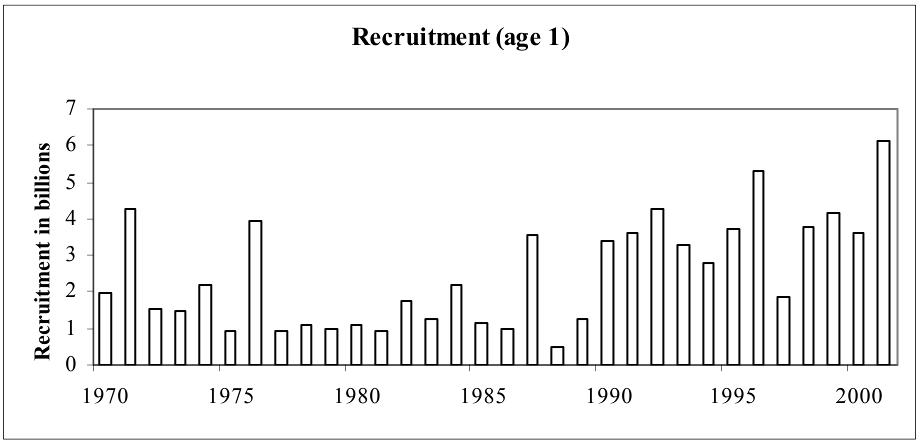
Year	ICES Advice	Predicted catch corresp. to advice	Agreed TAC	ACFM Catch
1987	Reduce F towards $\mathbf{F}_{0.1}$	8	-	13
1988	Reduce F towards $\mathbf{F}_{0.1}$	6	-	17
1989	F should not exceed present level	20	-	17
1990	F should not exceed present level	20	-	15
1991	No separate advice for this stock	-	-	15
1992	No separate advice for this stock	-	-	20
1993	No separate advice for this stock	-	-	22
1994	No separate advice for this stock	-	-	24
1995	No separate advice for this stock	-	-	33
1996	No separate advice for this stock	-	-	33
1997	Current exploitation rate within safe biological limits	35	-	40
1998	Current exploitation rate within safe biological limits	35	-	29
1999	Current exploitation rate within safe biological limits	34	-	31
2000	Current exploitation rate within safe biological limits	37	-	34
2001	Current exploitation rate within safe biological limits	34.1	-	39
2002	Current exploitation rate within safe biological limits	33.2	-	
2003	F=$\mathbf{F}_{pa}$	41		

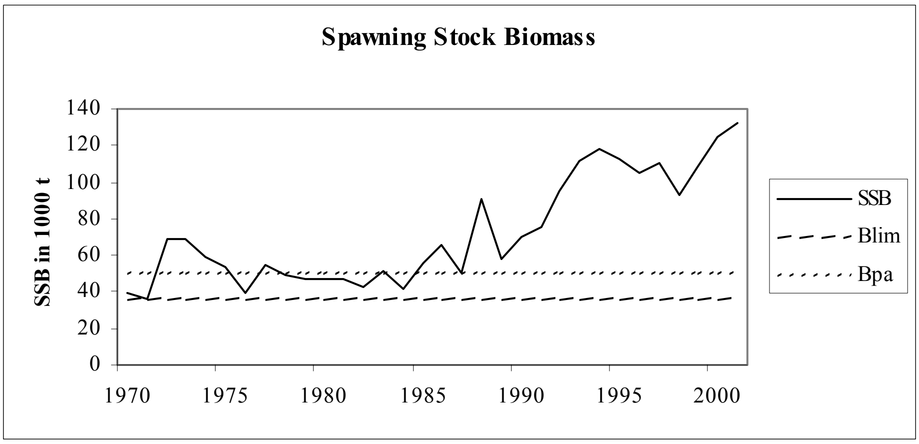
Weights in '000 t.

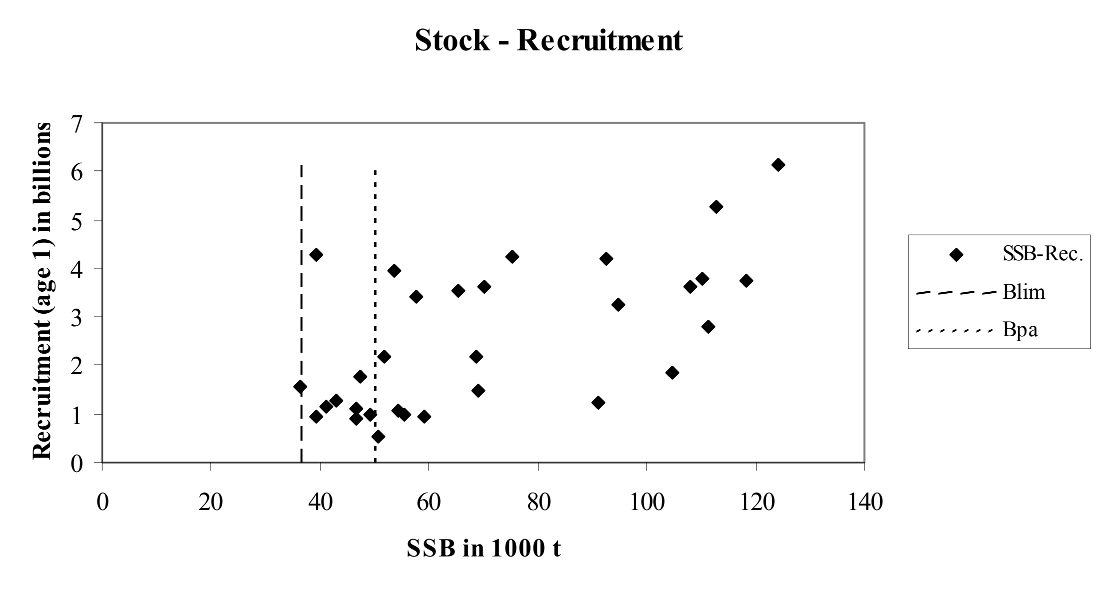
Gulf of Riga Herring

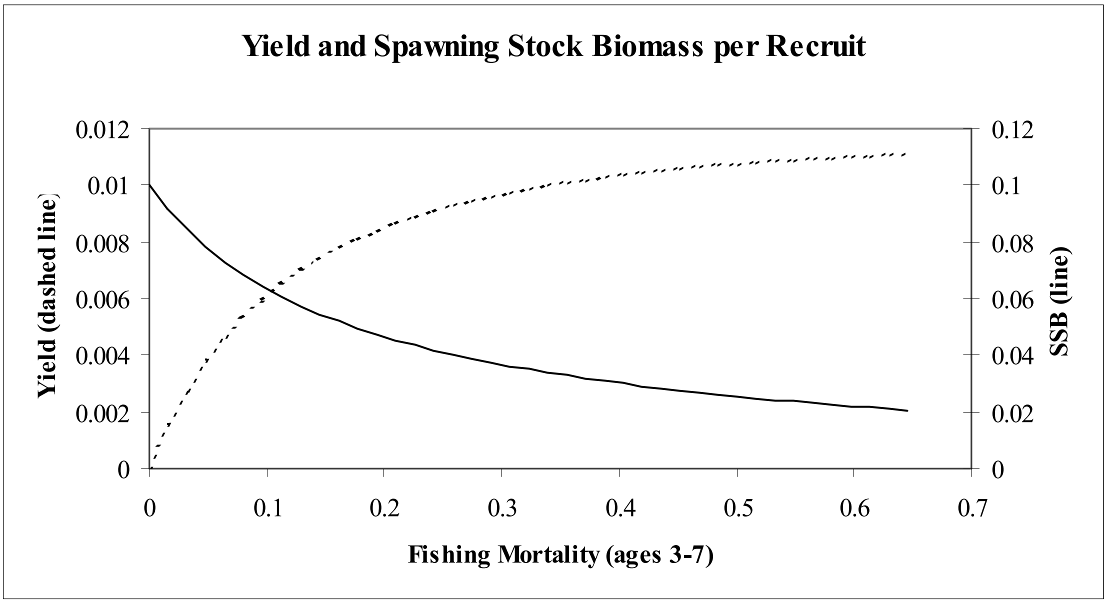









Stock - Recruitment
Recruitment (age 1) in billions
SSB in 1000 t
0
1
2
3
4
5
6
7
0
20
40
60
80
100
120
140
SSB-Rec.
Blim
Bpa


Yield and Spawning Stock Biomass per Recruit
Yield (dashed line)
SSB (line)
Fishing Mortality (ages 3-7)
0
0.002
0.004
0.006
0.008
0.01
0.012
0
0.02
0.04
0.06
0.08
0.1
0.12
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7

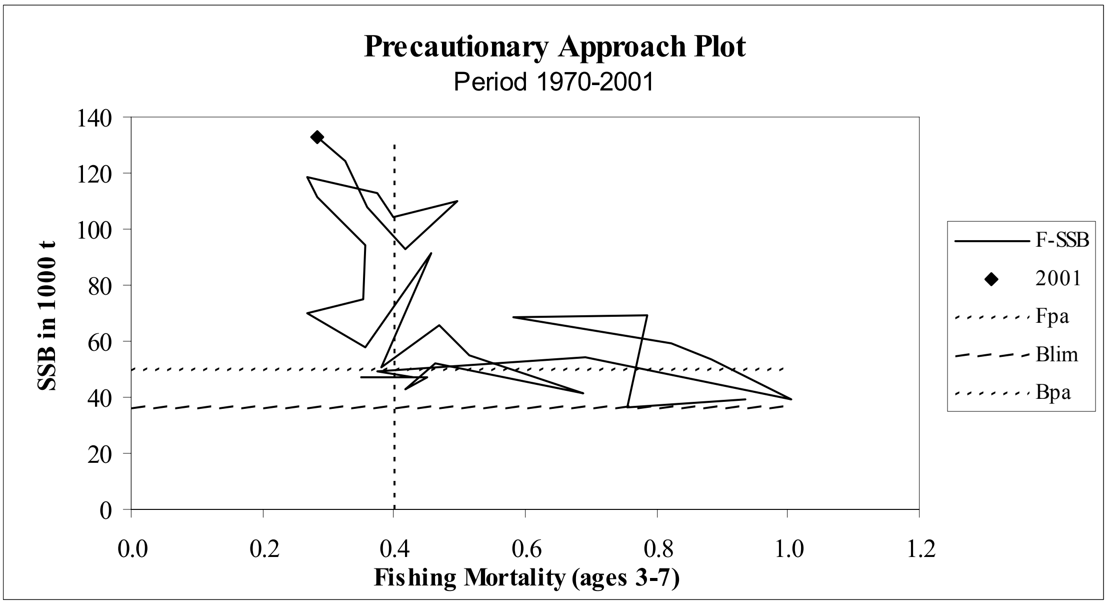

Precautionary Approach Plot
Period 1970-2001
SSB in 1000 t
Fishing Mortality (ages 3-7)
0
20
40
60
80
100
120
140
0.0
0.2
0.4
0.6
0.8
1.0
1.2
F-SSB
2001
Fpa
Blim
Bpa

Table 3.14.4.b.1 Herring catches in the Gulf of Riga by population and catches of Gulf of Riga herring outside the Gulf of Riga in the Latvian economical zone (Subdivision 28). The catch data corresponds to the official reported data until 1992 included. Data from 1993 onwards are scientific best estimates and differ from the officially reported catches. All catches in '000 t.

Year	Total catch in the Gulf of Riga	Total catch of the Gulf of Riga herring	Catch of Gulf of Riga herring in the Gulf of Riga	Catch of Gulf of Riga herring outside the Gulf of Riga*	Catch of Open sea herring in the Gulf of Riga
1976	31.9	27.4	27.4		4.5
1977	26.6	24.2	24.2		2.4
1978	23.0	16.7	16.7		6.3
1979	21.8	17.1	17.1		4.7
1980	20.7	15.0	15.0		5.7
1981	22.7	16.8	16.8		5.9
1982	17.5	12.8	12.8		4.7
1983	20.3	15.5	15.5		4.8
1984	19.6	15.8	15.8		3.8
1985	20.2	15.6	15.6		4.6
1986	18.2	16.9	16.9		1.3
1987	17.7	12.9	12.9		4.8
1988	19.8	16.8	16.8		3.0
1989	22.7	16.8	16.8		5.9
1990	20.8	14.8	14.8		6.0
1991	20.8	14.7	14.7		6.1
1992	23.9	21.5	20.2	1.3	3.8
1993	26.5	23.5	22.3	1.2	4.3
1994	27.2	24.3	22.2	2.1	5.0
1995	36.4	32.7	30.3	2.4	6.1
1996	32.7	32.6	28.3	4.3	4.4
1997	41.2	39.8	36.9	2.9	4.3
1998	30.7	29.4	26.6	2.8	4.1
1999	33.8	31.4	29.5	1.9	4.3
2000	37.4	34.1	32.9	1.2	4.5
2001	40.5	38.8	37.6	1.2	2.9

* Landings of the Gulf of Riga herring outside the Gulf were negligible and not estimated before 1992.

Table 3.14.4.b.2 Total catches (t) of herring in the Gulf of Riga by country (official statistics).

Year	Estonia	Latvia	Total
1991	7420	13481	20901
1992	9742	14204	23946
1993	9537	13554	23091
1994	9636	14050	23686
1995	16008	17016	33024
1996	11788	17362	29150
1997	15819	21116	36935
1998	11313	16125	27438
1999	10245	20511	30756
2000	12514	21624	34138
2001	14311	22775	37086

Table 3.14.4.b.3 Gulf of Riga Herring.

Year	Recruitment Age 1 thousands	SSB tonnes	Landings tonnes	Mean F Ages 3-7
1970	1983435	39488	33196	0.9345
1971	4282819	36328	32178	0.7561
1972	1553087	68934	27145	0.7857
1973	1484788	68607	27895	0.5826
1974	2173737	59327	30850	0.8225
1975	926694	53830	28523	0.8826
1976	3937407	39317	27422	1.0036
1977	943528	54548	24186	0.6899
1978	1077902	49388	16728	0.3748
1979	980827	46788	17142	0.4304
1980	1112491	46822	14998	0.3491
1981	916628	47368	16769	0.4509
1982	1752200	43159	12777	0.4176
1983	1273872	51917	15541	0.4637
1984	2195633	41092	15843	0.6888
1985	1172161	55308	15575	0.5143
1986	1007459	65358	16927	0.4705
1987	3532145	50817	12884	0.3799
1988	517057	91136	16791	0.4555
1989	1240577	57724	16783	0.3558
1990	3416619	70004	14931	0.2689
1991	3610404	75195	14791	0.3526
1992	4243930	94638	20000	0.3552
1993	3259439	111515	22200	0.2844
1994	2801310	118341	24300	0.2691
1995	3735211	112681	32656	0.3738
1996	5287380	104588	32584	0.3994
1997	1837661	110332	39843	0.4955
1998	3771040	92651	29443	0.4176
1999	4181828	108032	31403	0.3609
2000	3614071	124245	34069	0.3246
2001	6130414	132587	38785	0.2834
Average	2498555	72565	23599	0.4998

3.14.4.c Herring in Subdivisions 25–29 (including Gulf of Riga herring) and 32

State of stock/exploitation: The combined spawning biomass in these areas has continued to decrease and is close to the historic low. The fishing mortality increased throughout the late 1990s.

Management objectives: There are no explicit management objectives for these herring.

Catch forecast for 2003:
Basis: F(2002) = $\mathbf{F}_{sq}$ = F(1999–2001) = 0.44**,** Landings(2002) = 182, SSB(2002) = 425.

F(2003)	Basis	SSB(2003)	Landings (2003)	SSB (2004)
0	0 * $\mathbf{F}_{sq}$	491	0	665
0.09	0.2 * $\mathbf{F}_{sq}$	478	42	609
0.13	0.3 * $\mathbf{F}_{sq}$	472	62	584
0.18	0.4* $\mathbf{F}_{sq}$	466	81	559
0.22	0.5 * $\mathbf{F}_{sq}$	460	100	536
0.26	0.6 * $\mathbf{F}_{sq}$	454	118	513
0.35	0.8 * $\mathbf{F}_{sq}$	443	153	472
0.44	1.0 * $\mathbf{F}_{sq}$	432	185	434

Weights in '000 t.

Comparison with previous assessment and advice: The present assessment gives about 3% lower estimates of SSB(2001) and 1% higher fishing mortality for 2000 than last year's assessment.

Elaboration and special comment: The assessment is uncertain, due to the complexity of the stock structure and the uncertain split between herring and sprat in most pelagic fisheries in the area.

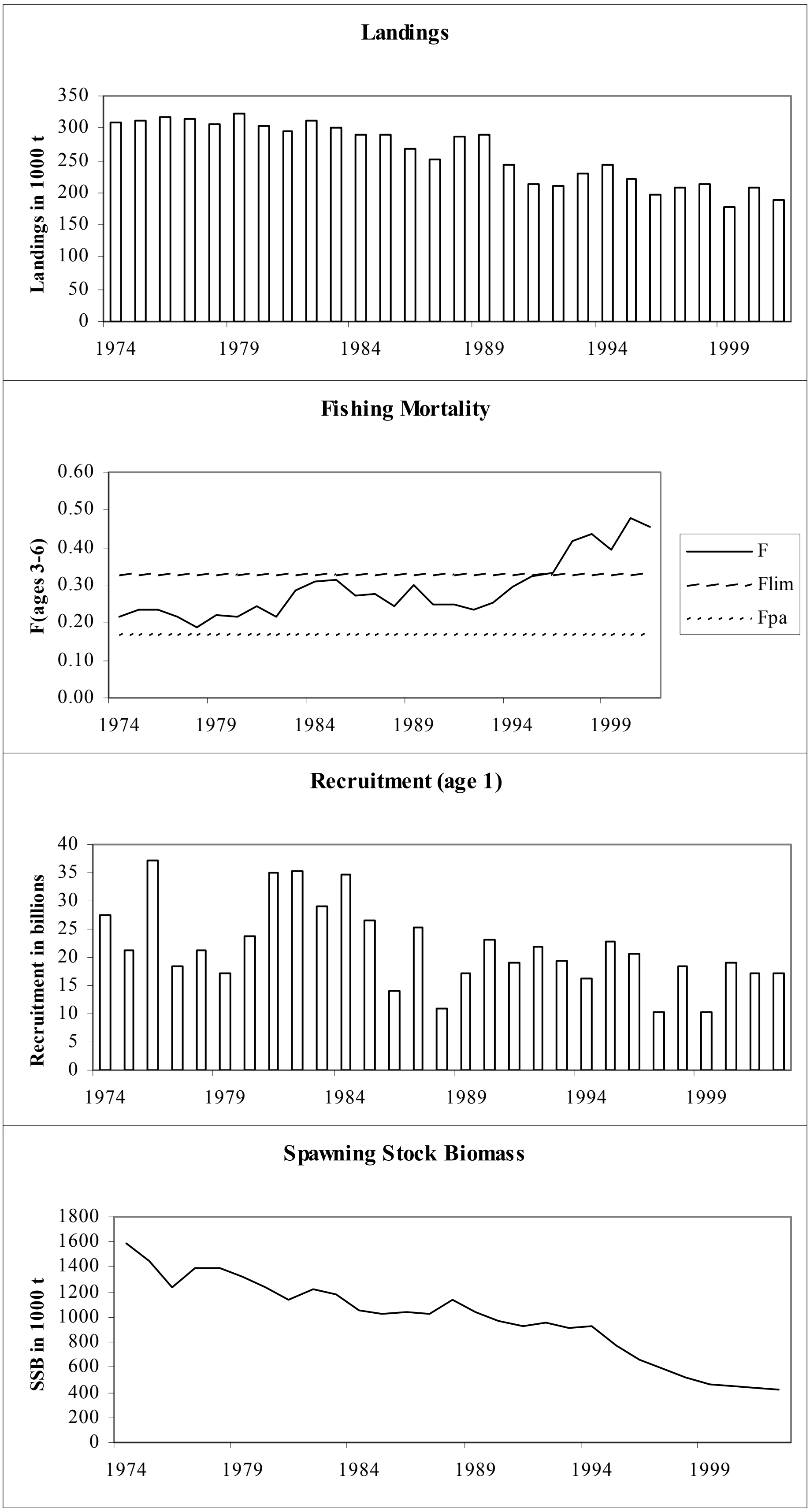

Landings
Landings in 1000 t
350
300
250
200
150
100
50
0
1974
1979
1984
1989
1994
1999
Fishing Mortality
F(ages 3-6)
0.60
0.50
0.40
0.30
0.20
0.10
0.00
F
Flim
Fpa
Recruitment (age 1)
Recruitment in billions
40
35
30
25
20
15
10
5
Spawning Stock Biomass
SSB in 1000 t
1800
1600
1400
1200
1000
800
600
400
200

Table 3.14.4.c.1 Herring in Subdivisions 25 to 29 and 32 plus Gulf of Riga.

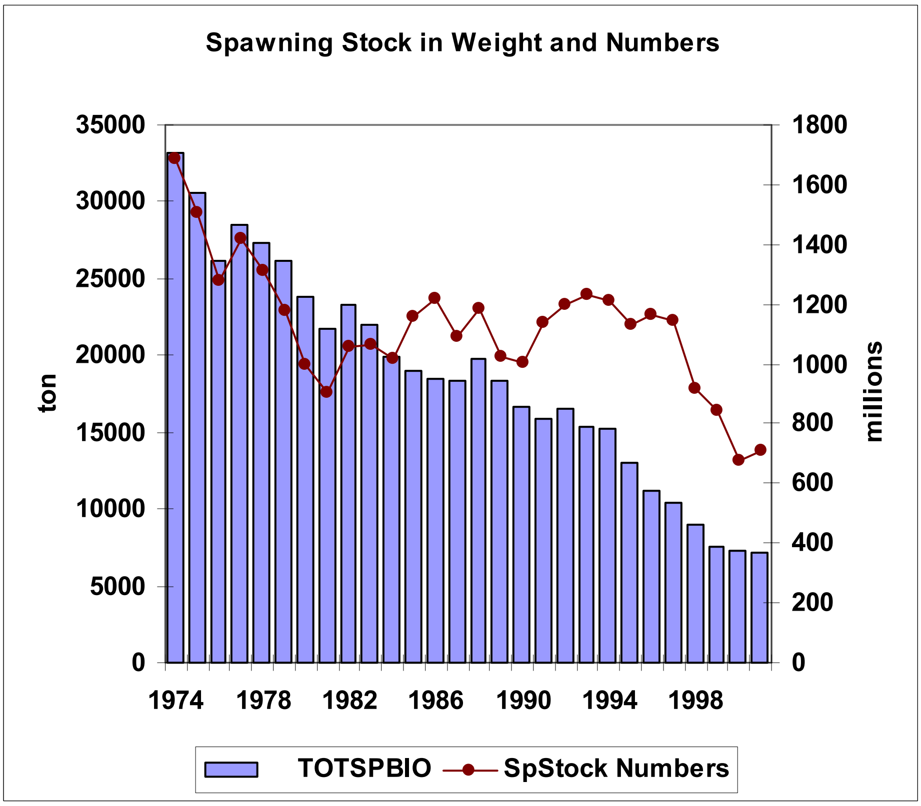
Year	Recruitment Age 1 thousands	SSB tonnes	Landings tonnes	Mean F Ages 3-6
1974	27383982	1586486	310000	0.2149
1975	21372180	1453671	313000	0.2363
1976	37112264	1243231	318000	0.2357
1977	18290166	1386430	314000	0.2160
1978	21295118	1391947	305000	0.1860
1979	17124404	1324719	323000	0.2207
1980	23788634	1240449	304000	0.2149
1981	34896916	1140344	294000	0.2432
1982	35410124	1222342	311000	0.2153
1983	29098356	1187938	302000	0.2836
1984	34698268	1055205	290000	0.3077
1985	26654396	1033082	290000	0.3149
1986	14004717	1036510	268000	0.2712
1987	25351026	1029799	252000	0.2774
1988	11092530	1135061	286000	0.2450
1989	17157618	1034475	290000	0.2979
1990	23020378	974983	244000	0.2490
1991	19064116	924571	213000	0.2479
1992	21764566	961744	210000	0.2332
1993	19322722	910375	231000	0.2514
1994	16296616	927017	244000	0.2944
1995	22915582	772342	221000	0.3237
1996	20525910	659632	196113	0.3347
1997	10295328	587281	207770	0.4160
1998	18434040	522147	214560	0.4354
1999	10246587	462357	178302	0.3929
2000	19006386	448379	207913	0.4767
2001	17308484	431142	187730	0.4544
2002	17309000	424880		0.4413
Average	21732428	983053	261621	0.2942

3.14.4.d Comparison between the Assessments

In order to illustrate the degree of consistency in the way that the separate assessments have been performed comparisons were made between the result from the whole area (Subdivisions 25-29, 32) and the sum of the results from Subdivisions 25-29 and 32 (Gulf of Riga excluded) and Gulf of Riga. The agreement between the sum of the parts and the whole is generally good for total stock biomass, average weight in the stock, spawning stock biomass, yield/SSB, and fishing mortality. However, differences are apparent in the numbers of recruits estimated in the earlier assessment years where the sum is smaller than the result from the whole area. The trends in stock development are similar for the two larger stock units where there is a declining trend, whilst the Gulf of Riga exhibits an increasing trend. Fishing mortalities in the earlier years of the assessment are higher in the Gulf of Riga than for the whole area; whilst for the most recent years they are lower.

SSB has steadily decreased in the stock complex for the time period for which an assessment is available. This is due to decreasing mean weight for a given age and in the latter part of the period also a decrease in the recruitment in numbers. The decrease in mean weights is partly because the stock centre shifted towards the north where herring have always been smaller than in more southerly areas, and partly because there was a direct decrease in growth rate. Figure 3.14.4.d.1 shows SSB in weight and in numbers. At the start of the period of decline it was the biomass that decreased while the number of fish was rather constant. In the latter part of the period the number of fish in the SSB also decreased. Figure 3.14.4.d.2 shows that mean age in the population has remained constant while the overall mean weight has decreased.

Source of information: Report of the Baltic Fisheries Assessment Working Group, 15–24 April 2002 (ICES CM 2002/ACFM:17).



3.14.5 Herring in Subdivision 30, Bothnian Sea

State of stock/exploitation: The stock is harvested outside safe biological limits. The spawning stock biomass has been high since the early 1990s, and is presently above $\mathbf{B}_{pa}$. The fishing mortality has increased since 1993, being above $\mathbf{F}_{pa}$ since 1997. The 1997, 1999, and 2000 year classes have been well above the long-term average.

Management objectives: There are no explicit management objectives for this stock. However, for any management objective to meet the precautionary criteria, F should be less than the $\mathbf{F}_{pa}$ and the spawning stock biomass should be maintained above the $\mathbf{B}_{pa}$.

Precautionary Approach reference points (unchanged since 2000):

ICES considers that:	ICES proposes that:
$\mathbf{B}_{lim}$ is 145 000 t	$\mathbf{B}_{pa}$ be set at 200 000 t
$\mathbf{F}_{lim}$ is 0.30	$\mathbf{F}_{pa}$ be set at 0.21

Technical basis:

$\mathbf{B}_{lim}$: spawning stock biomass, where probability of lower recruitment increases	$\mathbf{B}_{pa}$: $\mathbf{B}_{lim}$ *exp(1.645*0.2)
$\mathbf{F}_{lim}$: $\mathbf{F}_{loss}$	$\mathbf{F}_{pa}$: $\mathbf{F}_{med}$

Catch forecasts and advice on management for 2002, recommended by ICES in June 2001 and in March 2002:

Advice on management in June 2001: ICES recommends to reduce the fishing mortality to no more than $\mathbf{F}_{pa,}$ corresponding to landings of less than 39 500 t in 2002.

Advice on management in March 2002: The updated catch forecast suggests that the TAC for 2002 corresponding to $\mathbf{F}_{pa}$ is revised upwards from 39 500 t to 53 000 t. ICES maintains its advice to restrict fishing mortality to no more than $\mathbf{F}_{pa}$[=0.21].

The revised advice is based on the catch forecast and information supplied to ACFM in January 2002.

Advice on management for 2003: ICES recommends to reduce the fishing mortality to or below $\mathbf{F}_{pa}$, corresponding to landings of 50 000 t or less in 2003.

This advice is based on the catch forecast and information supplied to ACFM in May 2002:

Catch forecast for 2003:

Basis: F(2002) = F(1999–2001)= 0.24, Landings(2002) = 56, SSB(2002) = 258.

F(2002)	Basis	SSB(2003)	Landings (2003)	SSB (2004)	Medium-term effects of fishing at a given level
0.00	No fishing	260	0	298	High probability of SSB remaining above $\mathbf{B}_{pa}$
0.19	0.8*F(99–01)	253	45	247	Stable SSB
0.21	$\mathbf{F}_{pa}$=0.90*F(99-01)	252	50	242	Slowly decreasing SSB
0.24	$\mathbf{F}_{sq}$=1.00*F(99-01)	251	55	236	High probability of SSB will fall below $\mathbf{B}_{pa}$
0.26	1.1.*F(99–01)	250	60	231	High probability of SSB will fall below $\mathbf{B}_{pa}$
0.30	$\mathbf{F}_{lim}$=1.30*F(99–01)	249	69	221	High probability of SSB will fall below $\mathbf{B}_{pa}$

Weights in '000 t.
Shaded scenario considered inconsistent with the precautionary approach.

Relevant factors to be considered in management: This stock is part of the IBSFC management unit 3. The exploitation of the stock has increased in the 1990s, and according to medium-term projections (see figures below) the present fishing mortality is not sustainable. A reduction in fishing mortality to or below $\mathbf{F}_{pa}$ will give a high probability of keeping the spawning stock biomass above $\mathbf{B}_{pa}$.

Medium-term projections: Medium-term projections were calculated for a 10-year period. With the present fishing mortality (F = 0.24) there is a high probability that the stock will fall below $\mathbf{B}_{pa}$ in the medium-term and thus the present fishing mortality is not sustainable. With a reduction of 12 % to $\mathbf{F}_{pa}$ = 0.21, there is a high probability that the stock will stay above $\mathbf{B}_{pa}$ and catches will stay around 45 000 t in the medium-term.

Comparison with previous assessment and advice: This year's assessment gives about 17% higher estimates of spawning stock biomass (2000) than last years assessment and about 17 % decrease in fishing mortality compared to the 2001 assessment. This is largely due to revisions of the CPUE and catch data for 2000. The January 2002 assessment only used revised data up to and including 2000. The new assessment also included data for 2001. Compared to the January 2002 assessment the change in SSB(2000) is +5 % and +2 % in fishing mortality.

Elaboration and special comment: On average 90% of the total catch is taken by trawl fishery. Trapnet fishery is of minor importance. In the trawl fishery more effective and larger trawls have been introduced in the 1990s.

Source of information: Report of the Baltic Fisheries Assessment Working Group, April 2002 (ICES CM 2002/ACFM:17).

Yield and spawning biomass per Recruit
F-reference points:

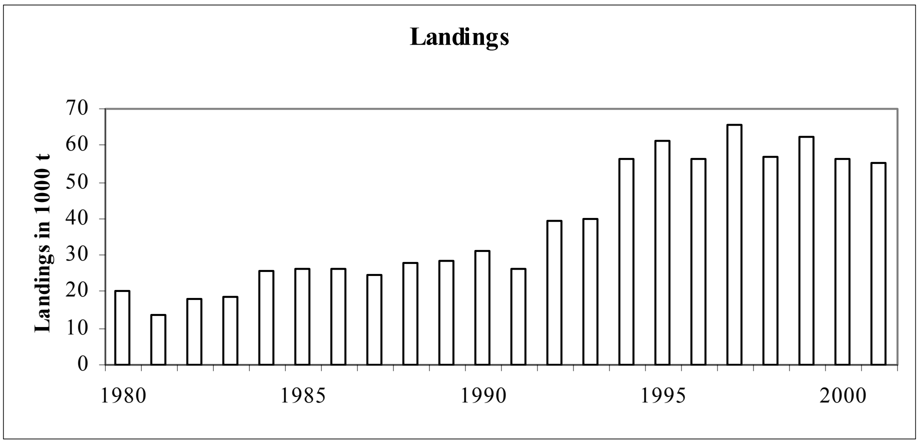
	Fish Mort Ages 3-7	Yield/R	SSB/R
Average Current	0.237	0.012	0.054
$\mathbf{F}_{max}$	0.546	0.013	0.029
$\mathbf{F}_{0.1}$	0.173	0.011	0.065
$\mathbf{F}_{med}$	0.222	0.012	0.056

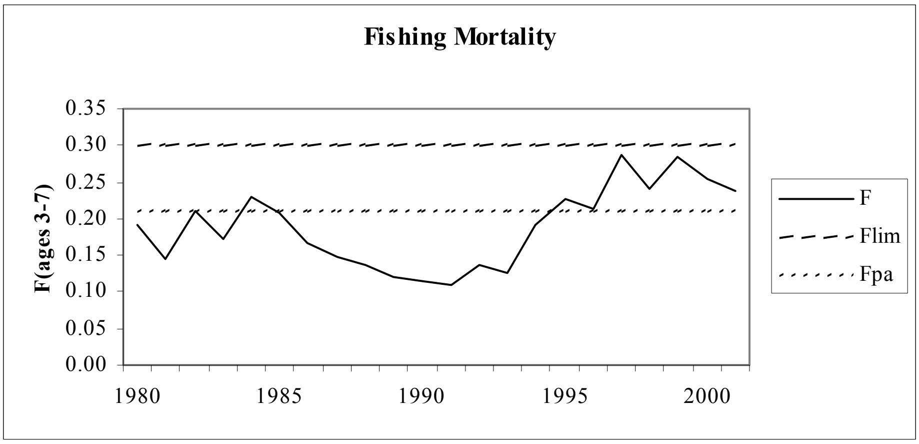
Catch data (Tables 3.14.5.1–2):

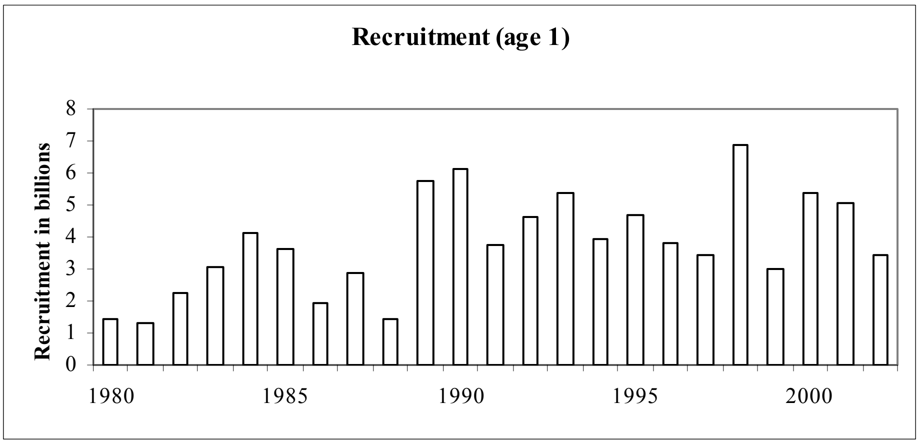
Year	ICES Advice	Predicted catch corresp. to advice	Agreed TAC[2]	ACFM Catch
1987				25
1988				28
1989				29
1990				31
1991	TAC for eastern part of SD, allowance for western part	32+	84	26
1992	*Status quo* F	39	84	39
1993	*Status quo* F	39	90	40
1994	No specific advice	41[1]	90	56
1995	TAC	73	110	61
1996	TAC	73	110	56
1997	F(97) = 1.4 * F(95)	78	110	61
1998	*Status quo* F	50	110	57
1999	Reduce catches	-	94	62
2000	Reduce catches	-	85	61
2001	$\mathbf{F}_{pa}$ = 0.21	36	72	55
2002	F below $\mathbf{F}_{pa}$	53	60	
2003	F below $\mathbf{F}_{pa}$	50		

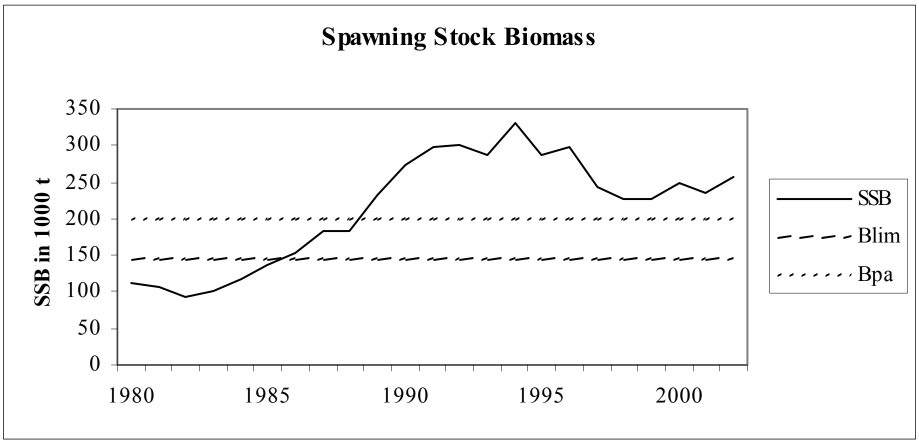
[1]Catch at F_{01}. [2]TAC for the area 29N, 30, 31, Management Unit 3. Weights in '000 t

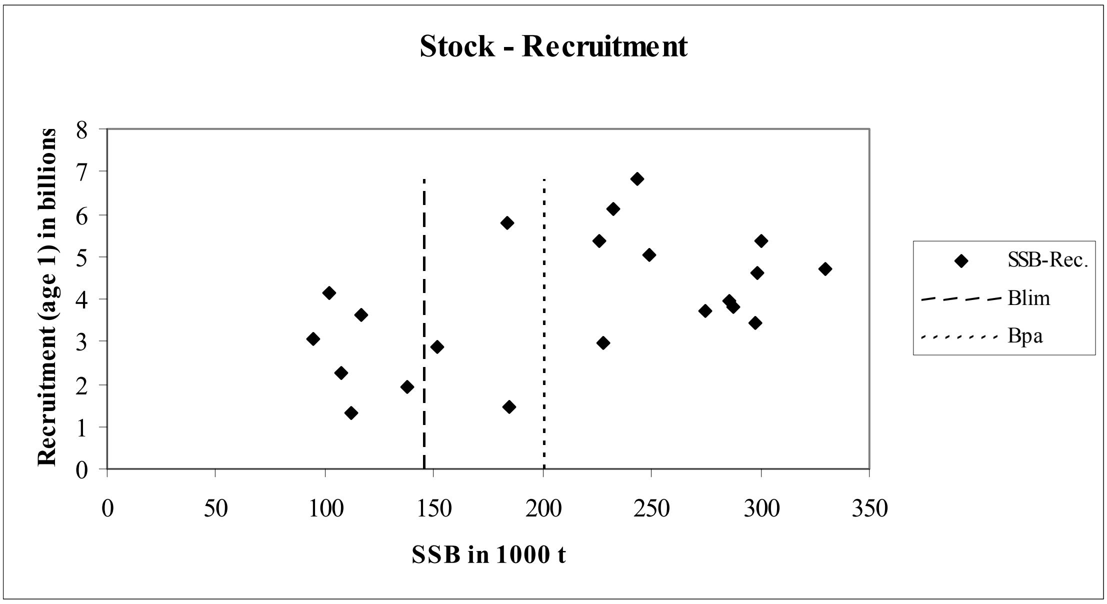
Herring in Subdivision 30, Bothnian Sea



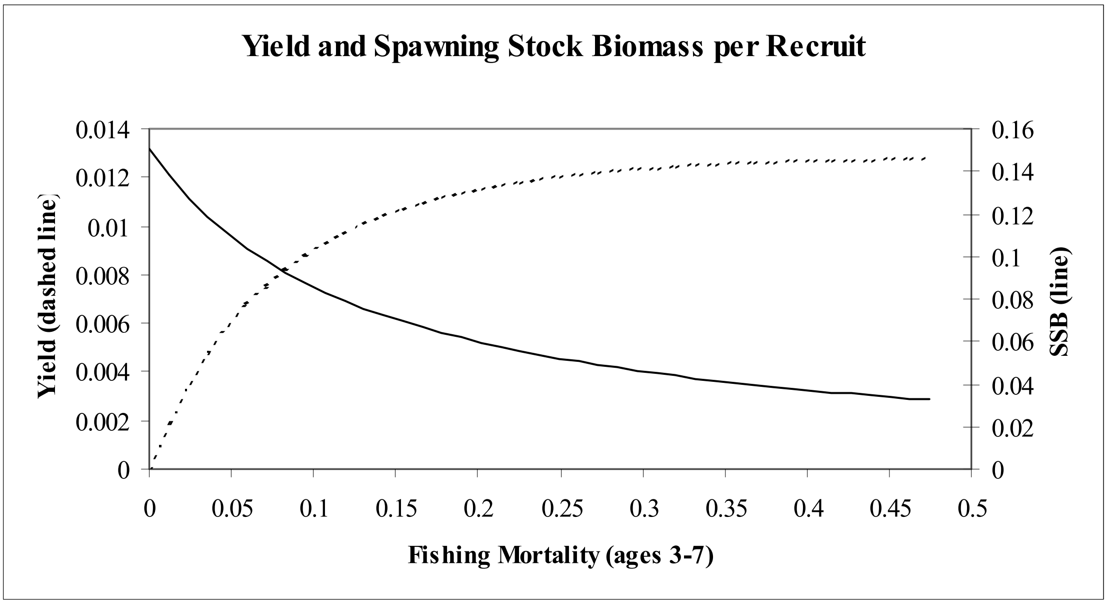




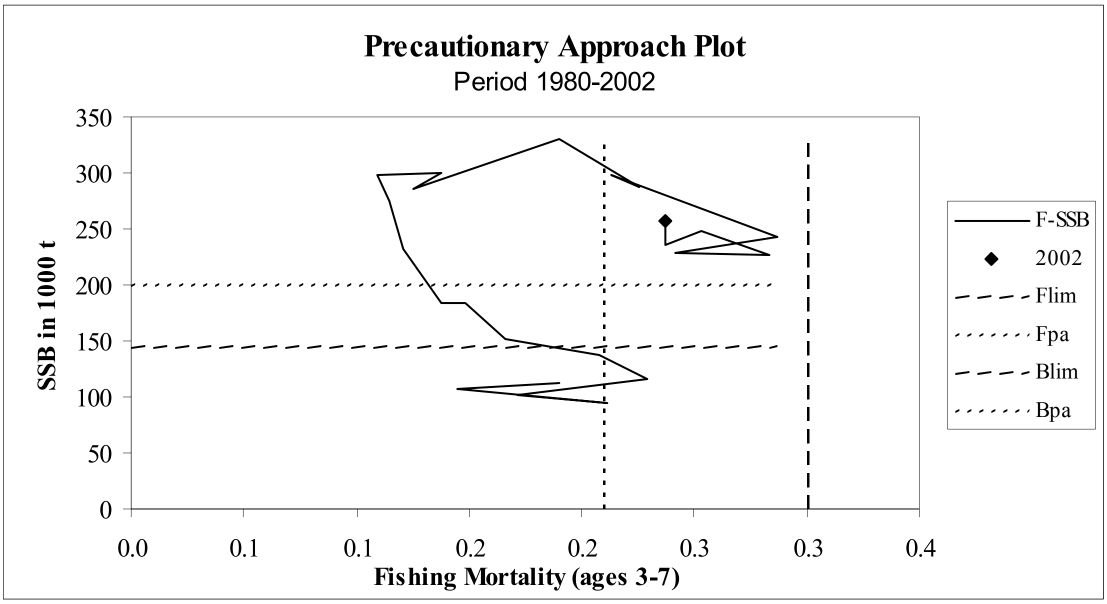




Stock - Recruitment
Recruitment (age 1) in billions
SSB in 1000 t
0
50
100
150
200
250
300
350
0
1
2
3
4
5
6
7
8
SSB-Rec.
Blim
Bpa

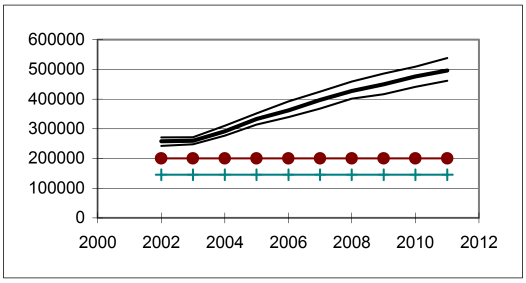


Yield and Spawning Stock Biomass per Recruit
Yield (dashed line)
SSB (line)
Fishing Mortality (ages 3-7)
0
0.002
0.004
0.006
0.008
0.01
0.012
0.014
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.05
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5

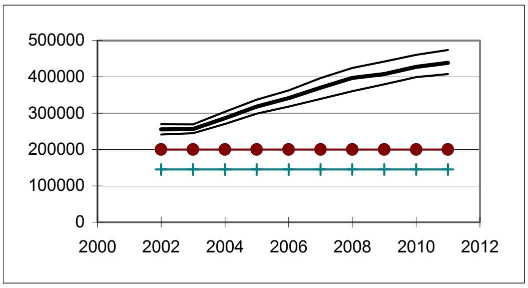


Precautionary Approach Plot
Period 1980-2002
SSB in 1000 t
Fishing Mortality (ages 3-7)
0
50
100
150
200
250
300
350
0.0
0.1
0.1
0.2
0.2
0.3
0.3
0.4
F-SSB
2002
Flim
Fpa
Blim
Bpa

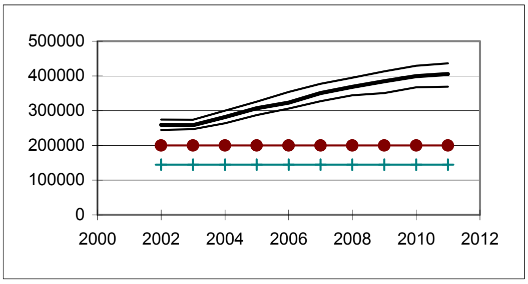
F=0.1



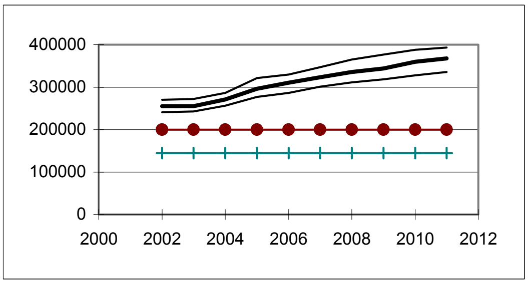
F=0.2



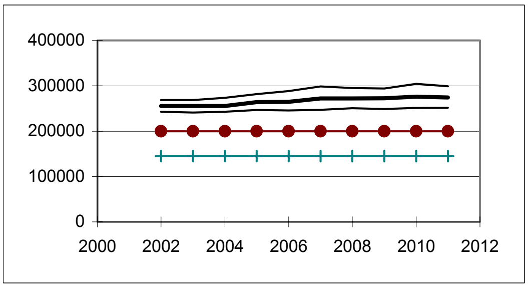
F=0.3



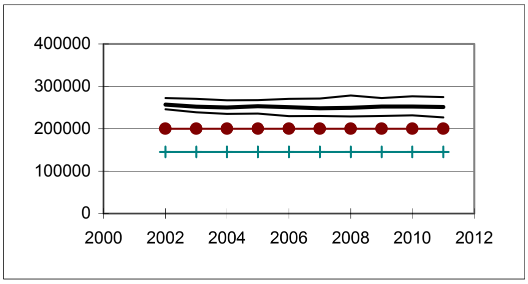
F=0.4



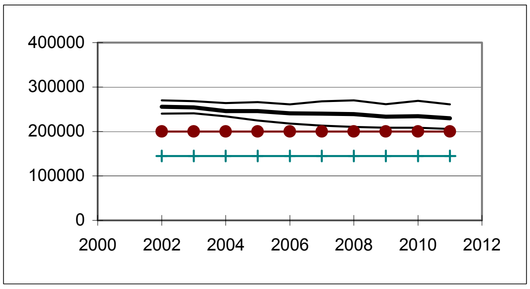
F=0.7



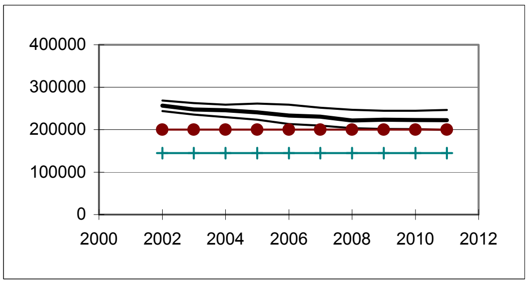
F=0.8



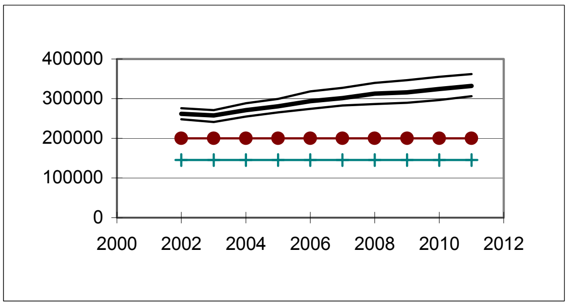
F=0.885 (Proposed Fpa = 0.21)



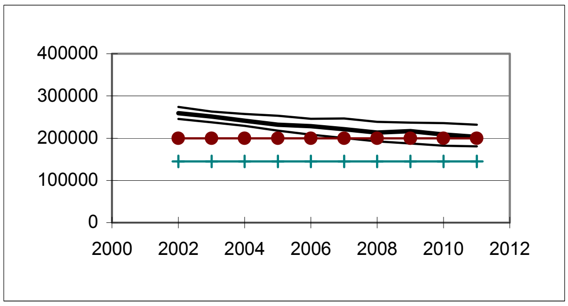
F=0.9



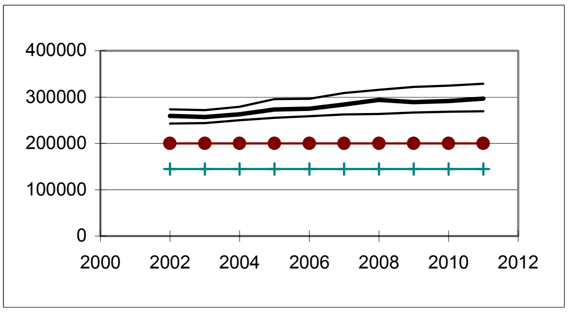
F=0.5



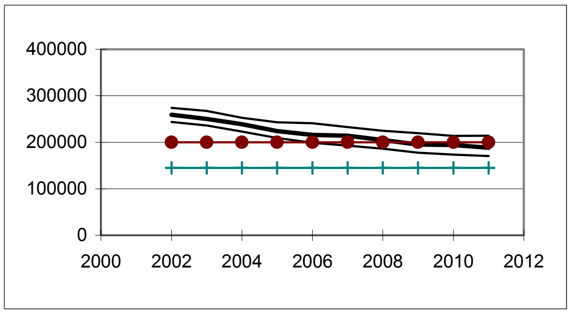
F=1.0 (Present situation, F = 0.237)



F=.0.6



F=1.1



F=1.265 (Proposed Flim = 0.30)

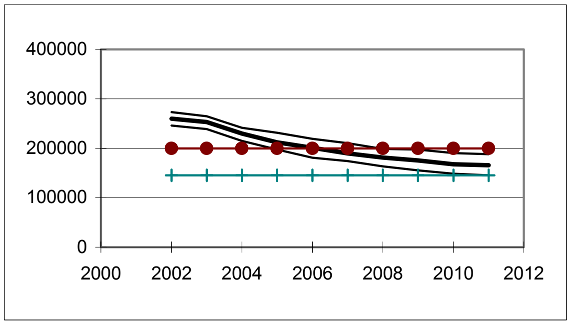


Table 3.14.5.1 Herring catches in Subdivision 30 (tonnes).

Year	Finland	Sweden	Total
1971	24,284	5,100	29,384
1972	24,027	5,700	29,727
1973	20,027	6,944	26,971
1974	17,597	6,321	23,918
1975	13,567	6,000	19,567
1976	19,315	4,455	23,770
1977	22,694	3,610	26,304
1978	22,215	2,890	25,105
1979	17,459	1,590	19,049
1980	18,758	1,392	20,150
1981	12,410	1,290	13,700
1982	16,117	1,730	17,847
1983	16,104	2,397	18,501
1984	23,228	2,401	25,629
1985	24,235	1,885	26,120
1986	23,988	2,501	26,489
1987	22,615	1,905	24,520
1988	24,478	3,172	27,650
1989	25,453	3,205	28,658
1990	28,815	2,467	31,282
1991	23,219	3,000	26,219
1992	35,610	3,700	39,310
1993	36,600	3,579	40,179
1994	53,860	2,520	56,380
1995	58,806	2,280	61,086
1996	54,372	1,737	56,109
1997	63,532	1,995	65,527
1998	54,115	2,777	56,892
1999	60,483	1,862	62,345
2000	54,886	1,374	56,261
2001*	52,987	1,997	54,984

* Preliminary.

Table 3.14.5.2 Herring in Subdivision 30, Bothnian Sea

Year	Recruitment Age 1 thousands	SSB tonnes	Landings tonnes	Mean F Ages 3-7
1980	1431119	112350	20150	0.1902
1981	1327299	107833	13700	0.1449
1982	2242894	94268	17847	0.2115
1983	3040281	101846	18501	0.1716
1984	4155972	116729	25629	0.2292
1985	3605147	138010	26120	0.2075
1986	1943887	151849	26489	0.1665
1987	2867795	184551	24520	0.1480
1988	1438384	183738	27650	0.1379
1989	5775958	232589	28658	0.1212
1990	6104184	274529	31282	0.1144
1991	3733040	298139	26219	0.1096
1992	4624036	300055	39310	0.1377
1993	5356150	285834	40179	0.1250
1994	3930684	329729	56380	0.1903
1995	4702399	287699	61086	0.2257
1996	3828827	297783	56109	0.2130
1997	3447903	243496	65527	0.2873
1998	6845491	228110	56892	0.2419
1999	2980171	226244	62345	0.2834
2000	5383043	248962	56261	0.2535
2001	5039921	235264	54984	0.2372
2002	3451343	257953		0.2372
Average	3793736	214677	37993	0.1906

Herring in Subdivision 30 (Bothnia Sea)

The Finnish Delegate to the same DG Fish meeting indicated that the catch in 2002 from this herring stock would be lower than the 56 000 tons on which ACFM has based its projections; they considered that a catch of 46 000 tons would be realistic. This downward adjustment was considered as the result of a closure of this fisheries in the summer months. A catch of 10 000 tons less than expected will increase the predicted catch in 2003 by approximately 2 000 tons and the expected SSB (2004) would increase by 7 000 tons if fishing at $\mathbf{F}_{pa}$ in 2003. The expected F(2002) will be lower at 0.19 (below $\mathbf{F}_{pa}$ (=0.21)) compared to the previously expected F(2002) of 0.24.

3.14.6 Herring in Subdivision 31, Bothnian Bay

State of stock/exploitation: The state of the stock is unknown, but the current assessment, although uncertain, indicates that the spawning stock biomass was high in the 1980s and has declined considerably since the mid-1990s to a very low level. Preliminary information suggests that year class 2000 is above average.

Management objectives: There are no explicit management objectives for this stock.

Precautionary Approach reference points: There are no Precautionary Reference points proposed for this stock.

Advice on management: ICES advises that the catch should not be allowed to increase above recent levels. This corresponds to catches of 3000 t in 2003.

Relevant factors to be considered in management: This stock is part of the IBSFC management unit 3. The herring TAC is set for IBSFC management unit 3, which includes Subdivisions 29N, 30, and 31.

Comparison with previous assessment and advice: Due to unreliable input data, this year's analytical assessment is considered exploratory only. Advice is based on CPUE series.

Elaboration and special comment: The main part of the total catch is taken by trawl fishery. Fluctuations in total trawl catches and the length of fishing seasons depend upon the onset of winter and ice cover in the autumn. Normally, the trawl fishing season starts in late April and stops for the spawning season in late May to July. Trawl fishery starts again in August/September. The ice cover usually appears in early November.

Recruitment is influenced not only by the size of the spawning stock, but to a large extent by the environmental conditions.

Source of information: Report of the Baltic Fisheries Assessment Working Group, 15 - 24 April 2002 (ICES CM 2002/ACFM:17).

Catch data (Tables 3.14.6.1–2):

Year	ICES Advice	Predicted catch corresp. to advice	Agreed TAC[1]	ACFM Catch
1987		9		8.1
1988		13		8.8
1989		7		4.4
1990		9		7.8
1991	TAC for eastern part of SD, allowance for western part	9+		6.8
1992	*Status quo* F	8		6.5
1993	Increase in yield by increasing F	-		9.2
1994	Increase in yield by increasing F	-		5.8
1995	Increase in yield by increasing F	18.4		4.7
1996	Increase in yield by increasing F	18.4		5.2
1997	Increase in yield by increasing F	-		4.3
1998	Increase in yield by increasing F	-		5.6
1999	Increase in yield by increasing F	-		4.2
2000	Increase in yield by increasing F	-		2.5
2001	Exploitation rate should not be increased.	-		2.8
2002	Exploitation rate should be decreased	-		
2003	No increase in catches	3		

[1]TAC for the area 29N, 30, 31, Management Unit 3. Weights in '000 t.

Herring in Subdivision 31, Bothnian Bay

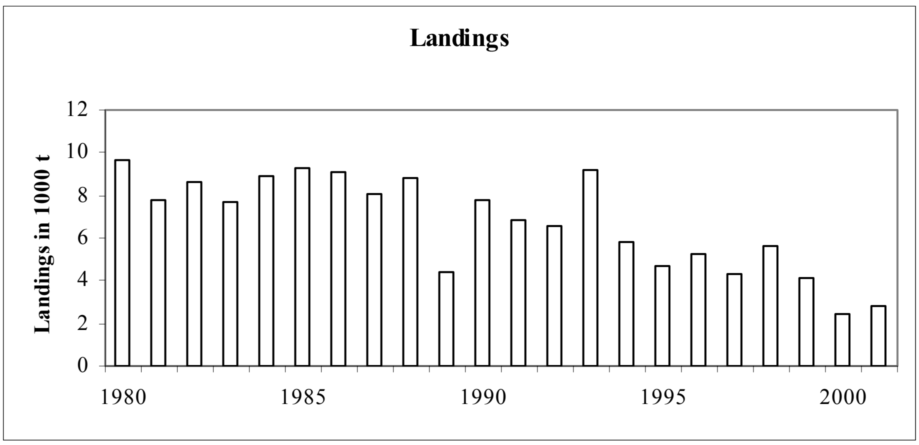


Table 3.14.6.1 Herring catches in Subdivision 31 (tonnes).

Year	Finland	Sweden	Total
1971	6,143	820	6,963
1972	3,550	770	4,320
1973	3,152	727	3,976
1974	5,737	665	6,482
1975	4,802	800	5,547
1976	7,763	750	8,508
1977	6,580	750	7,330
1978	9,068	700	9,768
1979	6,275	785	7,060
1980	8,899	760	9,659
1981	7,206	620	7,826
1982	7,982	670	8,652
1983	7,011	696	7,707
1984	8,322	594	8,916
1985	8,595	717	9,312
1986	8,754	336	9,090
1987	7,788	320	8,108
1988	8,501	267	8,768
1989	4,005	423	4,437
1990	7,603	295	7,818
1991	6,800	400	6,800
1992	6,900	400	6,540
1993	8,752	383	9,167
1994	5,195	411	5,825
1995	3,898	563	4,681
1996	5,080	114	5,249
1997	4,195	86	4,281
1998	5,358	224	5,582
1999	3,909	248	4,156
2000	2,479	113	2,592
2001*	2,755	67	2,821

* Preliminary.

Table 3.14.6.2 Herring in Subdivision 31, Bothnian Bay

Year	Recruitment Age 1 thousands	SSB tonnes	Landings tonnes	Mean F Ages 3-7
1980	789292	35327	9659	0.1740
1981	229612	32093	7826	0.2078
1982	169806	36716	8652	0.2331
1983	797531	31521	7707	0.2470
1984	553886	28773	8916	0.2311
1985	250989	31655	9312	0.2561
1986	217010	29929	9090	0.3562
1987	266634	26611	8108	0.3152
1988	91939	23898	8768	0.4003
1989	865780	19110	4437	0.2478
1990	386098	19430	7818	0.3264
1991	166079	22267	6800	0.2796
1992	256460	19503	6540	0.3421
1993	246069	17686	9167	0.5651
1994	143751	13164	5825	0.4413
1995	540155	10066	4681	0.4767
1996	365126	11355	5249	0.5244
1997	248972	10967	4281	0.5153
1998	182552	11857	5582	0.6591
1999	106147	9854	4153	0.7041
2000	663352	8514	2479	0.3161
2001	488187	11549	2821	0.2302
Average	364792	20993	6721	0.3659

3.14.7 Sprat in Subdivisions 22–32

State of stock/exploitation: The stock is within safe biological limits. SSB has decreased to 1 million t in 2002, and is slightly above the long-term average. In the most recent years the fishing mortality has almost doubled compared to the early 1990s and is close to $\mathbf{F}_{pa}$. The 1999 year class is estimated to be very strong, whereas the 2000 year class is estimated well below average. The 2001 year class is predicted to be below average.

Management objectives: In Resolution XIII, September 2000, the IBSFC agreed to implement a long-term management plan for sprat in the Baltic:

"The IBSFC agreed to implement a long-term management plan for the sprat stock which is consistent with a precautionary approach and designed to ensure a rational exploitation pattern and provide for stable and high yields. This plan shall consist of the following elements:

1. *Every effort shall be made to maintain a level of spawning stock biomass (SSB) greater than 200 000 t.*
2. *A long-term management plan, by which annual quotas shall be set for the fishery, reflecting a fishing mortality rate of 0.4 for relevant age groups as defined by ICES shall be implemented.*
3. *Should the SSB fall below a reference point of 275 000 t, the fishing mortality rate referred to under paragraph 2 will be adapted in the light of scientific estimates of the conditions then prevailing, to ensure safe and rapid recovery of the spawning stock biomass to levels in excess of 275 000 t.*
4. *The IBSFC shall, as appropriate, adjust management measures and elements of the plan on the basis of any new advice provided by ICES.*

A review of this arrangement shall take place not later than in the year 2003."

ICES considers that the agreed management plan is consistent with the precautionary approach, provided the reference points are used as upper bounds on F and lower bounds on SSB, and not as targets.

Precautionary Approach reference points (unchanged since 2000):

ICES considers that:	**ICES proposes that:**
$\mathbf{B}_{lim}$ is 200 000 t	$\mathbf{B}_{pa}$ be set at 275 000 t
$\mathbf{F}_{lim}$ is not yet defined	$\mathbf{F}_{pa}$ be set at 0.40

Technical basis:

$\mathbf{B}_{lim}$: MBAL	$\mathbf{B}_{pa}$: $\mathbf{B}_{lim}$*1.38; some sources of uncertainty in assessment taken into account
$\mathbf{F}_{lim}$: –	$\mathbf{F}_{pa}$:~ average $\mathbf{F}_{med}$ in recent years, allowing for variable natural mortality

Advice on management: The fishing mortality in 2003 should remain below F_{pa} corresponding to catches of less than 300 000 t. Such a TAC will only be in accordance with the Precautionary Approach if accompanied with measures that ensure a low by-catch of herring(< 15 %) in the mixed pelagic fishery.

Relevant factors to be considered in management: Landings increased from 1983, reaching a record high in 1997, and decreased thereafter. The increase in landings since 1992 is due to the development of an industrial pelagic fishery.

Most sprat are taken in mixed pelagic fisheries together with herring. If the status of the Central Baltic herring (in Subdivisions 25–29 and 32 (excluding Gulf of Riga)) is the dominating concern then management should ensure that herring catches in the mixed pelagic fisheries do not contribute to an overexploitation. Because of the technological interaction between sprat and herring in the mixed pelagic fishery such concerns imply a sprat TAC lower than 300,000 t and/or effective restrictions on the herring by-catch in the mixed pelagic fishery. There are indications that herring at present constitute about 35 % of the catches in the mixed pelagic fishery. Therefore, a sprat catch as low as 200 000 t in the mixed pelagic fishery in 2003 may use all available herring in Subdivisions 22-29+32 (72 000 t + 42 000 t= 114 000 t), Gulf of Riga excluded. However, there are also important herring fisheries in these Subdivisions that take little sprat by-catch.

The strong 1997 and 1999 year classes will still contribute to the yield, constituting ca. 36% of catches in 2003. The future of the fishery will depend greatly on the strength of future recruiting year classes. At present the year classes of 2000-2001 are estimated or predicted as below the average. The fishing mortality this stock can sustain is dependent on natural mortality, which is linked to the abundance of cod. Strong recruitment and low predation in recent years contributed to the high SSB in the mid-1990s. If the cod stock is to recover a much lower exploitation rate on sprat is necessary.

Catch forecast for 2003:

Basis: TAC; Landings(2002) = 380; F(2002) = 0.40, $\mathbf{F}_{sq}$ = 0.33.

F (2003)	Basis	Landings (2003)	SSB (2003)	SSB (2004)	Medium-term effect of fishing at given level
0.20	0.6 $\mathbf{F}_{sq}$	158	907	1074	High probability of SSB remaining above $\mathbf{B}_{pa}$
0.26	0.8 $\mathbf{F}_{sq}$	206	889	1014	High probability of SSB remaining above $\mathbf{B}_{pa}$
0.33	1.0 $\mathbf{F}_{sq}$	252	871	958	High probability of SSB remaining above $\mathbf{B}_{pa}$
0.36	1.1 $\mathbf{F}_{sq}$	274	862	931	High probability of SSB remaining above $\mathbf{B}_{pa}$
0.39	1.2. $\mathbf{F}_{sq}$	295	853	905	High probability of SSB remaining above $\mathbf{B}_{pa}$
0.40	$\mathbf{F}_{pa}$	300	855	899	High probability of SSB remaining above $\mathbf{B}_{pa}$
0.43	1.3 $\mathbf{F}_{sq}$	316	844	880	No medium projections for that F
0.46	1.4 $\mathbf{F}_{sq}$	337	836	856	No medium projections for that F

Weights in '000 t.

Shaded scenarios are considered to be inconsistent with the precautionary approach.

Medium- and long-term projections: The medians of spawning stock biomass under *status quo* fishing mortality tend to result in an equilibrium of about 870 000 t SSB (see figure below). Fisheries in 2005 and onwards will depend very heavily on the strengths of future recruitment.

Comparison with previous assessment and advice: This year's assessment gives about 30% higher estimates of spawning stock biomass for recent years than last year's assessment did, mostly as a result of applying new estimates of maturity-at-age. In terms of total stock biomass the difference is only 4%. The trend in stock development is similar in both assessments.

Elaboration and special comment: The assessment is based on catch data and acoustic surveys. Better sampling of industrial fisheries has improved the quality of the data input to the assessment.

Natural mortality is expected to vary over time as abundance of predators varies. Hence annual estimates of $\mathbf{F}_{med}$ are expected to continue to be variable, and multispecies interactions should be considered in setting precautionary reference points.

Sprat is fished with pelagic trawls during the first half and in the last few months of the year.

Source of information: Report of the Working Group on Baltic Fisheries Assessment, 15 – 24 April 2002 (ICES CM 2002/ACFM:17).

Yield and spawning biomass per Recruit
F-reference points:

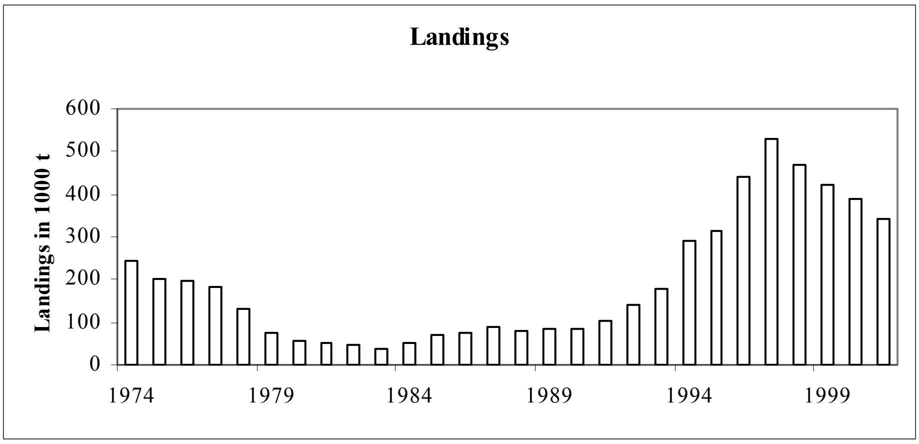
	Fish Mort Ages 3-5	Yield/R	SSB/R
Average Current	0.329	0.004	0.012
$\mathbf{F}_{max}$	2.388	0.005	0.002
$\mathbf{F}_{0.1}$	0.516	0.004	0.009
$\mathbf{F}_{med}$	0.297	0.003	0.013

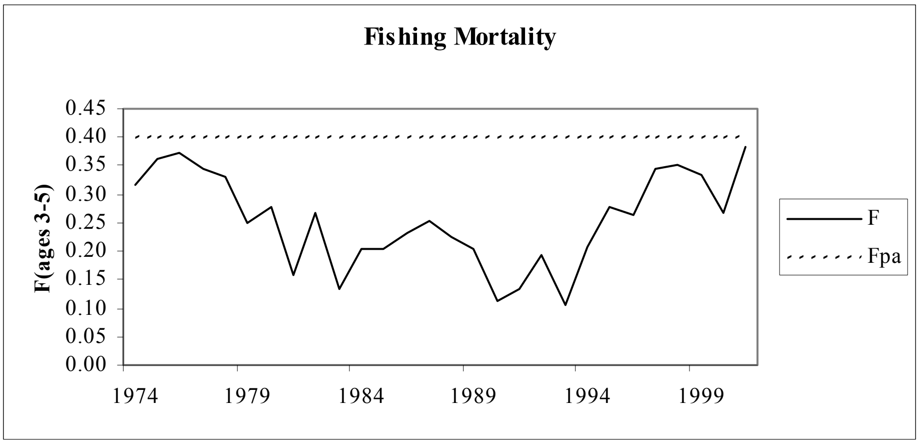
Catch data (Tables 3.14.7.1–3):

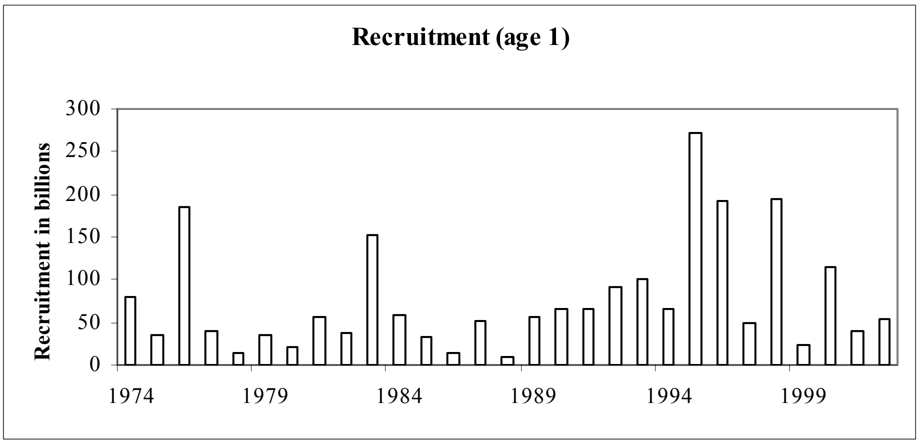
Year	ICES Advice	Predicted catch corresp. to advice	Agreed TAC	ACFM catch
1987			117.2	88
1988	Catch could be increased in SD 22–25	-	117.2	80
1989		72	142	86
1990		72	150	86
1991	TAC	150	163	103
1992	*Status quo* F	143	290	142
1993	Increase in yield by increasing F	-	415	178
1994	Increase in yield by increasing F	-	700	289
1995	TAC	205	500	313
1996	Little gain in long-term yield at higher F	279	550	441
1997	No advice	-	550	529
1998	*Status quo* F	343	550	471
1999	Proposed $\mathbf{F}_{pa}$	304	467.5	421
2000	Proposed $\mathbf{F}_{pa}$	192	400	389
2001	Proposed $\mathbf{F}_{pa}$	314	355	342
2002	Proposed $\mathbf{F}_{pa}$	369	380	
2003	Below proposed $\mathbf{F}_{pa}$	300		

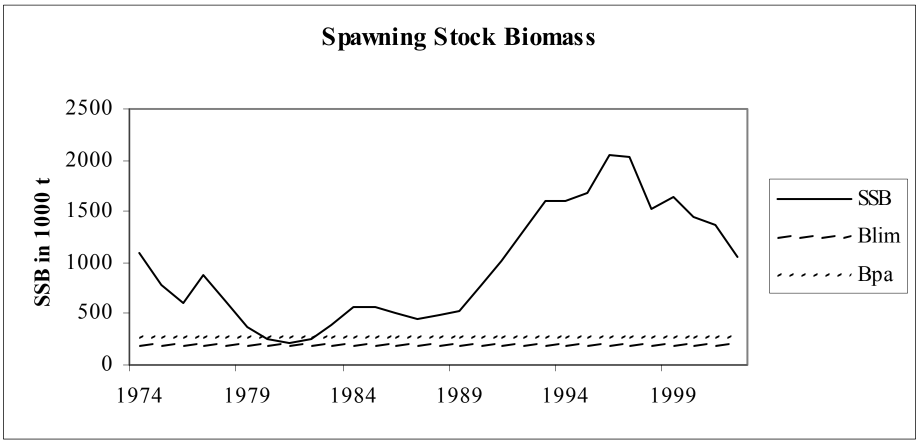
Weights in '000 t.

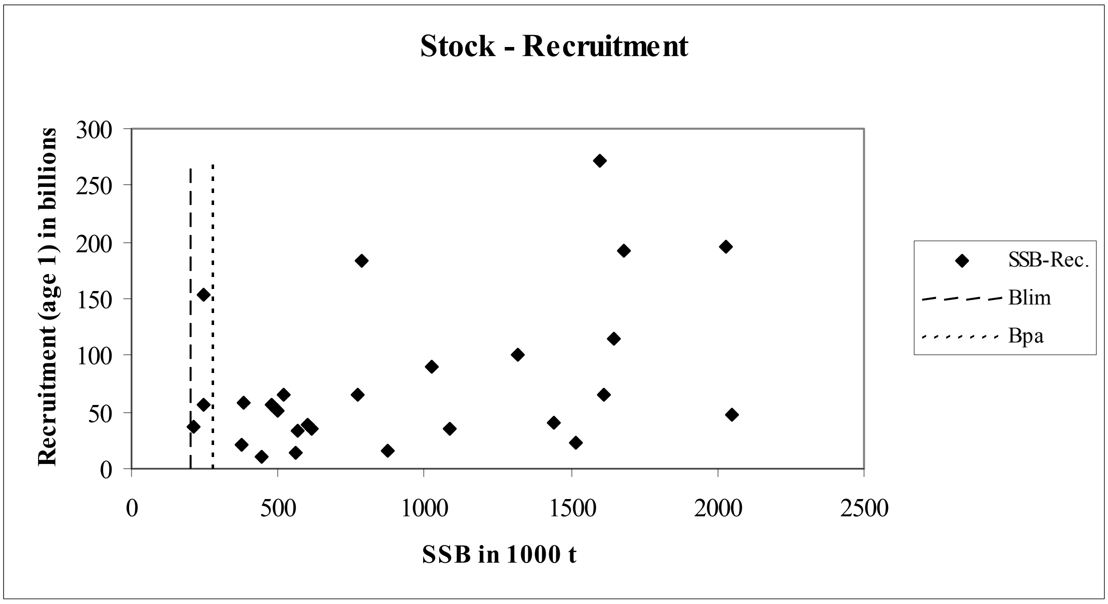
Sprat in Subdivisions 22 to 32



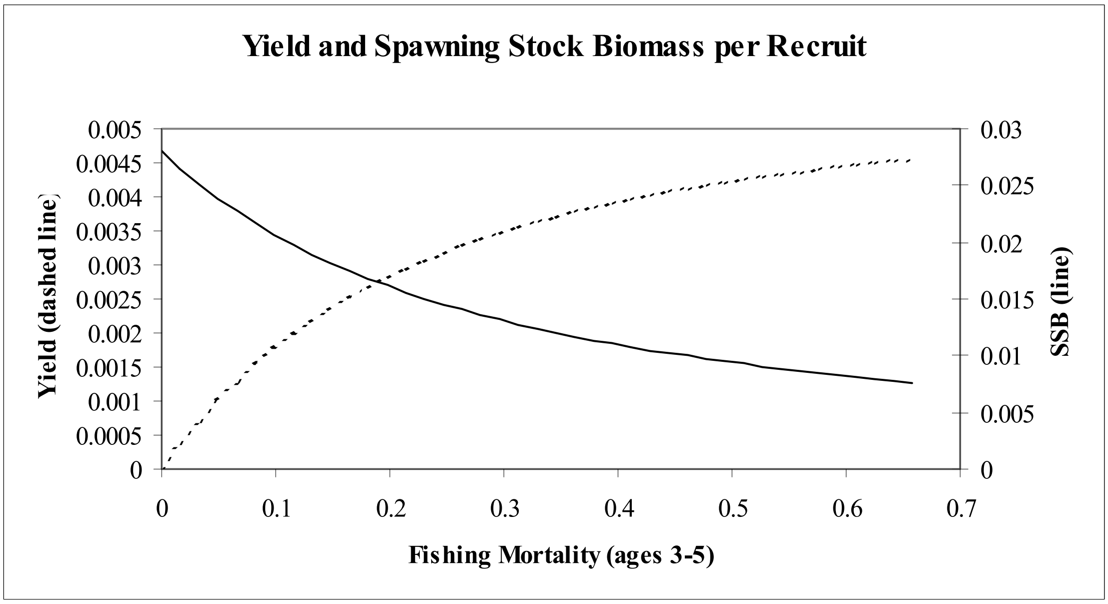




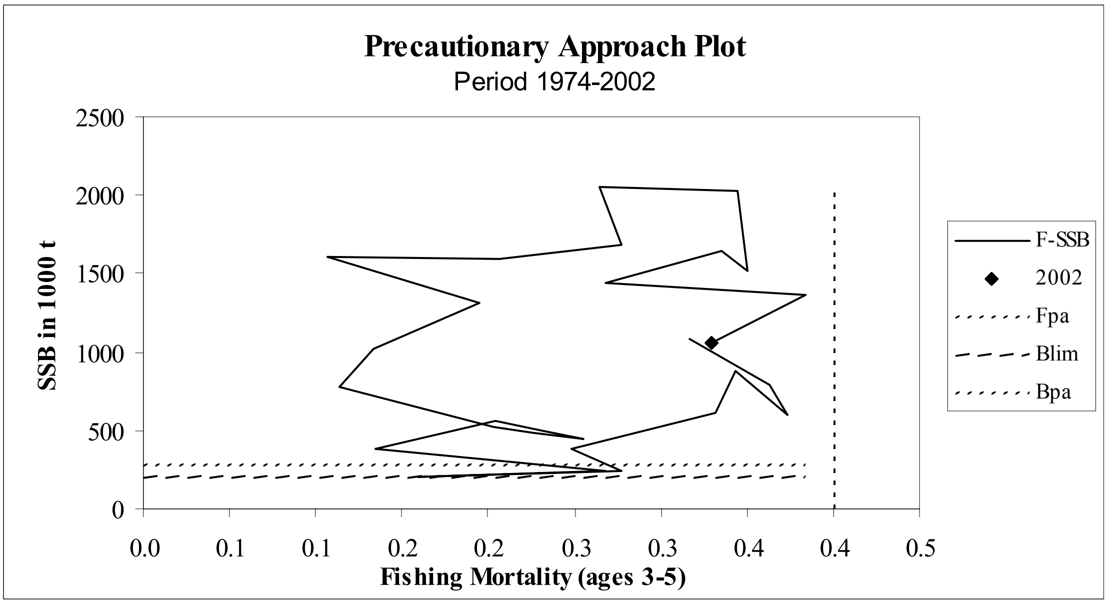




Stock - Recruitment
Recruitment (age 1) in billions
SSB in 1000 t
SSB-Rec.
Blim
Bpa
0
50
100
150
200
250
300
500
1000
1500
2000
2500



Yield and Spawning Stock Biomass per Recruit
Yield (dashed line)
SSB (line)
Fishing Mortality (ages 3-5)
0
0.0005
0.001
0.0015
0.002
0.0025
0.003
0.0035
0.004
0.0045
0.005
0.005
0.01
0.015
0.02
0.025
0.03
0.1
0.2
0.3
0.4
0.5
0.6
0.7



Precautionary Approach Plot
Period 1974-2002
SSB in 1000 t
Fishing Mortality (ages 3-5)
F-SSB
2002
Fpa
Blim
Bpa
0
500
1000
1500
2000
2500
0.0
0.1
0.1
0.2
0.2
0.3
0.3
0.4
0.4
0.5

Table 3.14.7.1 Sprat catches in Subdivisions 22-32 (thousand tonnes).

Year	Denmark	Finland	German Dem. Rep.	Germany Fed. Rep.	Poland	Sweden	USSR	Total
1977	7.2	6.7	17.2	0.8	38.8	0.4	109.7	180.8
1978	10.8	6.1	13.7	0.8	24.7	0.8	75.5	132.4
1979	5.5	7.1	4.0	0.7	12.4	2.2	45.1	77.1
1980	4.7	6.2	0.1	0.5	12.7	2.8	31.4	58.1
1981	8.4	6.0	0.1	0.6	8.9	1.6	23.9	49.3
1982	6.7	4.5	1.0	0.6	14.2	2.8	18.9	48.7
1983	6.2	3.4	2.7	0.6	7.1	3.6	13.7	37.3
1984	3.2	2.4	2.8	0.7	9.3	8.4	25.9	52.5
1985	4.1	3.0	2.0	0.9	18.5	7.1	34.0	69.5
1986	6.0	3.2	2.5	0.5	23.7	3.5	36.5	75.8
1987	2.6	2.8	1.3	1.1	32.0	3.5	44.9	88.2
1988	2.0	3.0	1.2	0.3	22.2	7.3	44.2	80.3
1989	5.2	2.8	1.2	0.6	18.6	3.5	54.0	85.8
1990	0.8	2.7	0.5	0.8	13.3	7.5	60.0	85.6
1991	10.0	1.6		0.7	22.5	8.7	59.7*	103.2

Year	Denmark	Estonia	Finland	Germany	Latvia	Lithuania	Poland	Russia	Sweden	Total
1992	24.3	4.1	1.8	0.6	17.4	3.3	28.3	8.1	54.2	142.1
1993	18.4	5.8	1.7	0.6	12.6	3.3	31.8	11.2	92.7	178.1
1994	60.6	9.6	1.9	0.3	20.1	2.3	41.2	17.6	135.2	288.8
1995	64.1	13.1	5.2	0.2	24.4	2.9	44.2	14.8	143.7	312.6
1996	109.1	21.1	17.4	0.2	34.2	10.2	72.4	18.2	158.2	441.0
1997	137.4	38.9	24.4	0.4	49.3	4.8	99.9	22.4	151.9	529.4
1998	91.8	32.3	25.7	4.6	44.9	4.5	55.1	20.9	191.1	470.8
1999	90.2	33.2	18.9	0.2	42.8	2.3	66.3	31.5	137.3	422.6
2000	51.5	39.4	20.2	0.0	46.2	1.7	79.2	30.4	120.6	389.1
2001	39.7	37.5	15.4	0.8	42.8	3.0	85.8	32.0	85.4	342.2

* Sum of catches by Estonia, Latvia, Lithuania, and Russia.

Table 3.14.7.2 Sprat catches in the Baltic Sea by country and Subdivision (thousand tonnes).

Year 2000

Country	**Total**	22	24	25	26	27	28	29	30	31	32
Denmark	**51.5**	9.4	0.8	41.2[1)]	-	-	-	-	-	-	-
Estonia	**39.4**	-	-	-	-	-	6.1	13.9	-	-	19.4
Finland	**20.2**	-	-	-	-	-	-	3.6	4.8	0.0	11.9
Germany	**0.0**	0.0		-	-	-	-	-	-	-	-
Latvia	**46.2**	-	-	2.6	7.3	-	36.3	-	-	-	-
Lithuania	**1.7**	-	-	-	1.7	-	-	-	-	-	-
Poland	**79.2**	-	0.8	40.5	37.9	-	-	-	-	-	-
Russia	**30.4**	-	-	-	28.3	-	2.0	-	-	-	-
Sweden	**120.6**	-	2.1	31.7	13.2	31.5	23.9	18.1	-	-	-
Total	**389.1**	**9.5**	**3.7**	**116.0**	**88.4**	**31.5**	**68.3**	**35.5**	**4.8**	**0.0**	**31.4**

1) Danish catches in Subdivision 25 include catches in Subdivision 22 and 24.

Year 2001

Country	**Total**	22	24	25	26	27	28	29	30	31	32
Denmark	**39.7**	-	-	39.7	-	-	-	-	-	-	-
Estonia	**37.5**	-	-	-	-	-	6.3	16.1	-	-	15.1
Finland	**15.4**	-	-	-	-	-	-	4.5	3.2	0.001	7.6
Germany	**0.8**	0.02	0.8	-	-	-	-	-	-	-	-
Latvia	**42.8**	-	-	1.1	7.0	-	34.7	-	-	-	-
Lithuania	**3.0**	-	-	-	3.0	-	-	-	-	-	-
Poland	**85.8**	-	0.4	46.3	39.1	-	-	-	-	-	-
Russia	**32.0**	-	-	-	29.6	-	2.3	-	-	-	-
Sweden	**85.4**	-	1.0	2.9	4.8	27.8	30.2	18.1	-	-	0.5
Total	**342.2**	**0.02**	**2.1**	**90.0**	**83.5**	**27.8**	**73.5**	**38.7**	**3.2**	**0.001**	**23.2**

Table 3.14.7.3 Sprat in Subdivisions 22 to 32.

Year	Recruitment Age 1 thousands	SSB tonnes	Landings tonnes	Mean F Ages 3-5
1974	80739784	1085562	241700	0.3171
1975	34969544	788091	201434	0.3627
1976	184219024	603117	194775	0.3730
1977	38712492	876202	180800	0.3433
1978	15139242	616397	132360	0.3321
1979	34679796	377036	77100	0.2480
1980	21271416	245430	58100	0.2771
1981	57217320	209428	49300	0.1588
1982	36682008	246146	48700	0.2680
1983	152834096	382517	37320	0.1350
1984	58809696	563605	52560	0.2045
1985	33702176	557726	69497	0.2040
1986	14178983	500816	75800	0.2324
1987	50610848	441995	88276	0.2547
1988	10390906	479152	80300	0.2259
1989	56788788	521374	85817	0.2033
1990	64922852	771931	85578	0.1140
1991	65201312	1021711	103200	0.1329
1992	90605040	1318050	142195	0.1946
1993	100316200	1610706	178100	0.1067
1994	65220188	1596946	288700	0.2067
1995	271201344	1682829	313000	0.2777
1996	192472800	2051117	441100	0.2644
1997	48403188	2031208	529400	0.3442
1998	195520512	1516159	470770	0.3508
1999	23591778	1642891	421397	0.3348
2000	115018096	1441311	389140	0.2683
2001	40859168	1369864	342200	0.3838
2002	54828000	1052855		0.3290
Average	76176090	951799	192094	0.2568

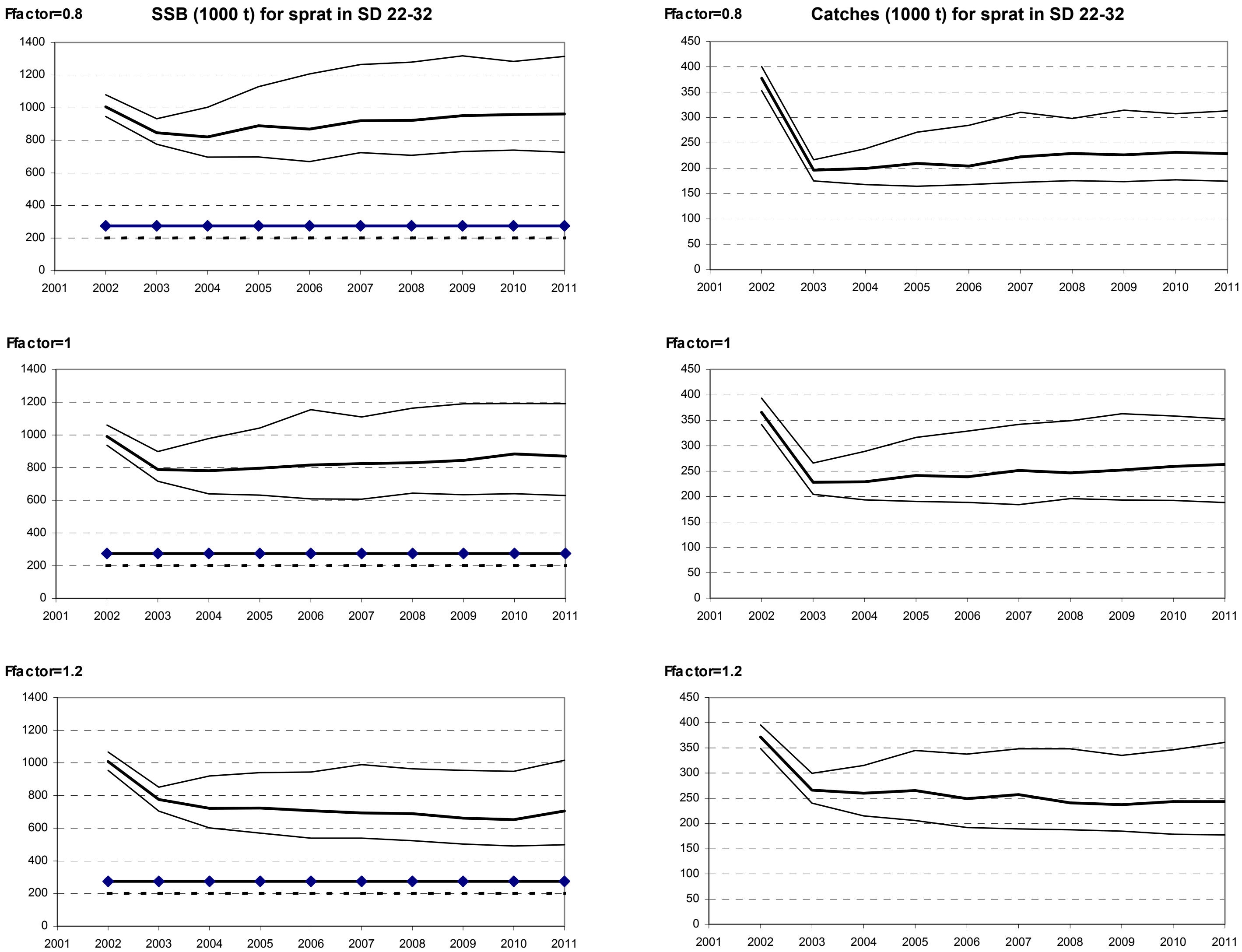


Fig. 12.2.13.1a Sprat in SD 22-32. Medium term projections of biomass. Fig. 12.2.13.1b Sprat in SD 22-32. Medium term projections of ca (25.5

Medium-term projections. The percentiles presented are 25%, 50% and 75%. B_{pa} = 275 000 t and B_{lim} = 200 000 t. Ffactor of 1 represent F_{sq} = 0.35.

Sprat in Subdivisions 22-29

A misprint in SSB for 2002 (Table 3.14..7.3) has been identified in the summary table for SSB for 2002. This number given in the table is not used anywhere in the calculations. The correct figure is given in the catch option table and should be SSB (2002) = 1 025 120 tons and not as given in Table 3.14.7.3, 1 052 855 tons.

3.14.8 Cod in Subdivisions 22–24 (including Subdivision 23)

State of the stock/exploitation: The stock is outside safe biological limits. The present fishing mortality is 1.2, above the fishing mortality of 1.0 agreed by IBSFC. SSB is estimated to be 20 800 t in 2002, below the $\mathbf{B}_{pa}$ (23 000 t). The 2001 year class is estimated to be close to average strength.

Management objectives: IBSFC have adopted a long-term management strategy for cod in the Baltic (Section 3.14.1). For Baltic cod there is one management unit covering all Subdivisions 22–32. ICES considers the stocks in Subdivisions 22–24 and Subdivisions 25–32 as separate stocks, however, and advice is provided on them separately. ICES reiterates its advice that the cod stocks should be managed separately in order to better adapt the exploitation to the present development in the two stocks. With this caveat ICES considers that the agreed management plan is consistent with the precautionary approach, provided the reference points are used as upper bounds on F and lower bounds on SSB, and not as targets.

Reference points: There is doubt about whether these cod form a closed population, as there may be substantial exchange with adjacent cod stocks. Such exchange could inflate R/SSB reference points, which are very high for this stock, e.g. $\mathbf{F}_{med}$ = 1.08, and the high fishing mortality estimates may not accurately represent the exploitation rate for the unit stock. Further consideration of the magnitude and consequences of exchange is needed before establishing an appropriate $\mathbf{F}_{lim}$..

Precautionary Approach reference points (Unchanged since 1999):

ICES considers that:	ICES proposes that:
$\mathbf{B}_{lim}$ is not yet defined	$\mathbf{B}_{pa}$ be set at 23 000 t
$\mathbf{F}_{lim}$ is not yet defined	$\mathbf{F}_{pa}$ is not yet defined

Technical basis:

-	Previous MBAL
-	-

Advice on management: ICES recommends that the fishing mortality in 2003 should be reduced below the F of 1.0 agreed by IBSFC. The corresponding landings depend on whether the new fishing rule will improve the exploitation pattern. Catch options for both scenarios are presented. This cod stock should be managed separately from the stock in Sub-divisions 25-32 in order to better adapt the exploitation to the present development in the stock.

Relevant factors to be considered in management: Whether the potential improvement of the exploitation pattern from the new fishing rule will be realized is questioned. It has been observed that technical manipulations of the gear can negate the effectiveness of the new fishing rules. If this practice is widespread the exploitation pattern will not improve.

The fishery is largely based on recruiting year classes, and discarding is substantial. An increase in the minimum trawl mesh size, as agreed by IBSFC to be implemented during 2002, may significantly reduce the amount of discards.

The catch forecast is sensitive to the estimated size of the 2001 year class, which will account for about 50% of the yield in 2003. This year class is estimated to be of around average strength.

The stock has been rebuilt from the low SSBs of the early 1990s as a result of strong recruitment, especially from the 1994, 1996, and 1997 year classes. The patterns of recruitment to this stock over time and relative to spawning biomass suggest that there may be recruitment dispersal and/or migration between this stock and adjacent cod stocks in the Baltic and/or Kattegat.

Catch forecast for 2003:

A; Assuming no selectivity change.

Basis: F(2002) = $\mathbf{F}_{sq}$ = 1.23; Landings(2002) = 29.3; SSB(2003) = 28.8.

F (2003)	Basis	Landings (2003)	Discards (2003)	SSB (2004)
0	0	0	0	58.5
0.25	0.2 $\mathbf{F}_{sq}$	9.2	1.0	47.7
0.49	0.4 $\mathbf{F}_{sq}$	16.8	1.9	39.6
0.74	0.6 $\mathbf{F}_{sq}$	23.1	2.7	33.1
0.98	0.8 $\mathbf{F}_{sq}$	28.4	3.4	27.9
1.0	F_{IBSFC} (0.82 $\mathbf{F}_{sq}$)	28.8	3.4	27.5
1.23	$\mathbf{F}_{sq}$	32.9	4.0	23.6

Weights in 000 t.

Shaded scenarios considered inconsistent with the precautionary approach.

B; Assuming an effective change in selectivity (introduced at start of 2003):

Basis: F(2002) = $\mathbf{F}_{sq}$ = 1.23; Landings(2002) = 29.3; SSB(2003) = 28.8.

F (2003)	Basis	Landings (2003)	Discards (2003)	SSB (2004)
0	0	0	0	58.5
0.22	0.2 $\mathbf{F}_{sq}$	6.4	0.4	50.8
0.44	0.4 $\mathbf{F}_{sq}$	11.8	0.8	45.1
0.66	0.6 $\mathbf{F}_{sq}$	16.6	1.2	40.4
0.88	0.8 $\mathbf{F}_{sq}$	20.7	1.6	36.4
1.0	F_{IBSFC} (0.9 $\mathbf{F}_{sq}$)	22.6	1.7	34.7
1.10	$\mathbf{F}_{sq}$	24.3	1.9	33.1

Weights in 000 t.
Shaded scenarios considered inconsistent with the precautionary approach.

Medium- and long-term projections: Medium-term projections were simulated over 10 years, using the IBSFC agreed F of 1.0. The outcome show a high probability of SSB increasing above the $\mathbf{B}_{pa}$ of 23 000 t. The long-term projection reference points are estimated as $\mathbf{F}_{0.1}$=0.16 and $\mathbf{F}_{max}$=0.26. The input and results from the yield-per-recruit analysis estimates S/R reference points at $\mathbf{F}_{med}$= 1.04, $\mathbf{F}_{high}$=1.74, and $\mathbf{F}_{low}$=0.43.

Comparison with previous assessment and advice: The current assessment now includes discard data. The current assessment has revised the estimate of the SSB in 2000 7% downwards. The state of the stock has changed with respect to safe biological limits due to the reduced influence of strong year classes. The advice is consistent with last year's advice.

Elaboration and special comment: As a result of the high fishing mortality, SSBs and yield are dependent on ages 2–4. The contribution of ages 2 and 3 in the yield has for recent years been around 70% of the landings. The estimates of the size of the year classes attaining these ages in the forecast are uncertain, being based in part on recruited fish or solely on research survey information. For the period 1992–1994 landings are uncertain due to incomplete reporting; however, the data quality has improved significantly since then.

Source of information: Report of the Baltic Fisheries Assessment Working Group, 15 – 24 April 2002 (ICES CM 2002/ACFM:17), and Technical Minutes of ACFM, May 2002.

Yield and spawning biomass per Recruit
F-reference points:

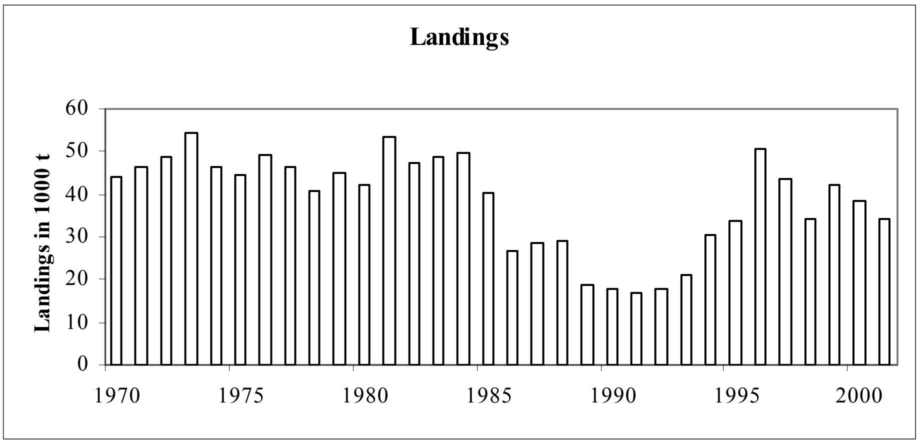
	Fish Mort Ages 3-6	Yield/R	SSB/R
Average Current	1.211	0.603	0.389
$\mathbf{F}_{max}$	0.263	0.855	2.839
$\mathbf{F}_{0.1}$	0.162	0.804	4.343
$\mathbf{F}_{med}$	1.043	0.625	0.480

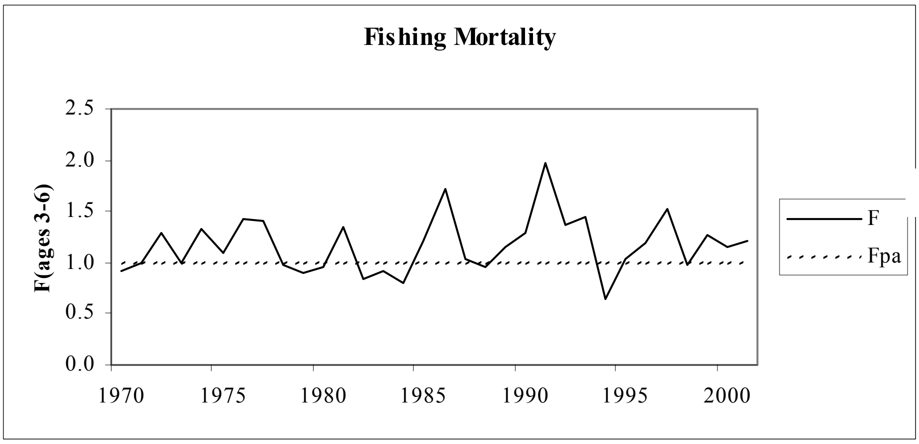
Catch data (Tables 3.14.8.1–2):

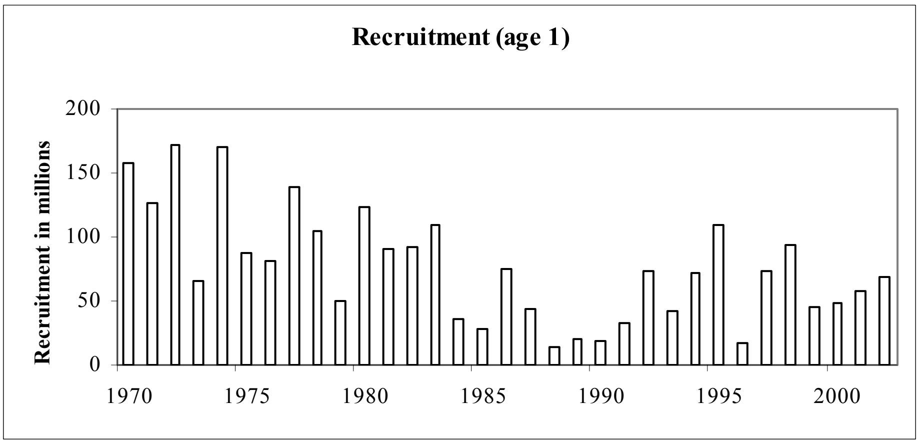
Year	ICES Advice	Predicted catch corresp. to advice	Agreed TAC[1]	ACFM Catch (22–24)	ACFM Catch (22–32)
1987	TAC	9		29	236
1988	TAC	16		29	223
1989	TAC	14	220	19	198
1990	TAC	8	210	18	171
1991	TAC	11	171	17	140
1992	Substantial reduction in F	-	100	18	73[2]
1993	F at lowest possible level	-	40	21	66[2]
1994	TAC	22	60	31	124[2]
1995	30% reduction in fishing effort from 1994 level	-	120	34	142[2]
1996	30 % reduction in fishing effort from 1994 level	-	165	51	173
1997	Fishing effort should not be allowed to increase above level in recent years	-	180	44	132
1998	20% reduction in F from 1996	35	160	34	102
1999	At or below $\mathbf{F}_{sq}$ with 50% probability	38	126	42	115
2000	Reduce F by 20%	44.6	105	38	104
2001	Reduce F by 20%	48.6	105	34	102
2002	Reduce F to below 1.0	36.3	76		
2003	Reduce F to below 1.0	See option table			

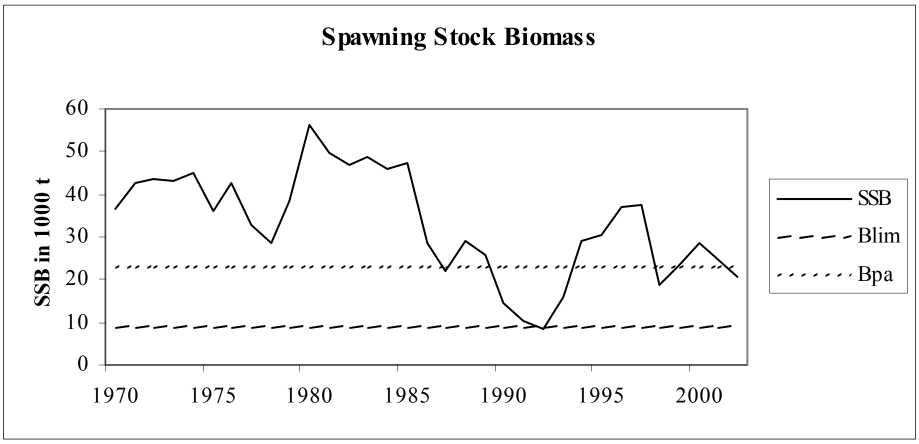
[1] Included in TAC for total Baltic. [2] The reported landings in 1992–1995 are known to be incorrect due to incomplete reporting. Weights in '000 t.

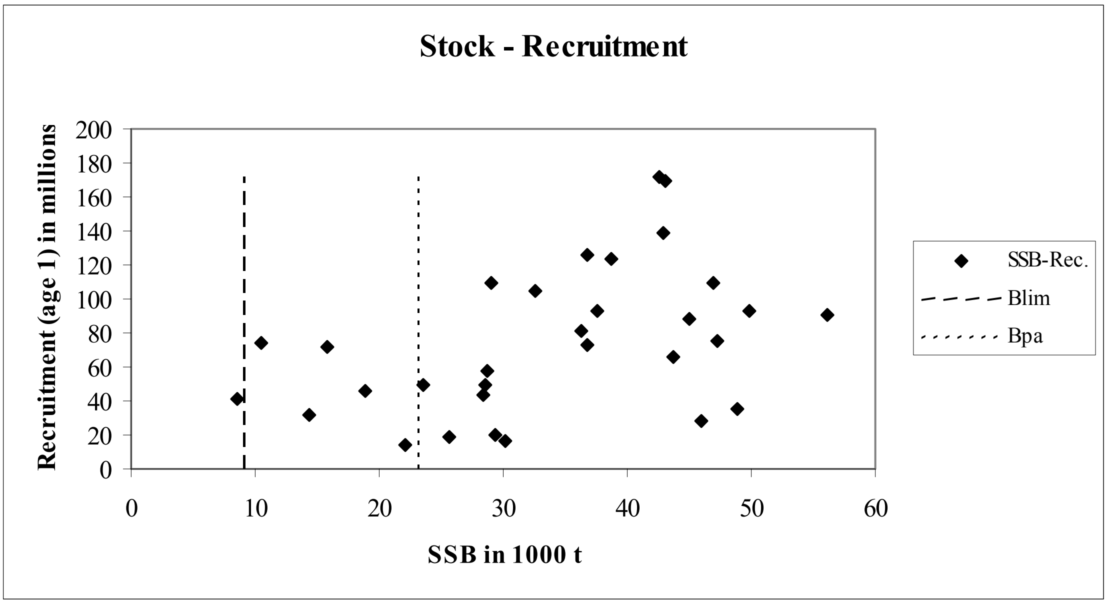
Cod in Subdivisions 22 to 24

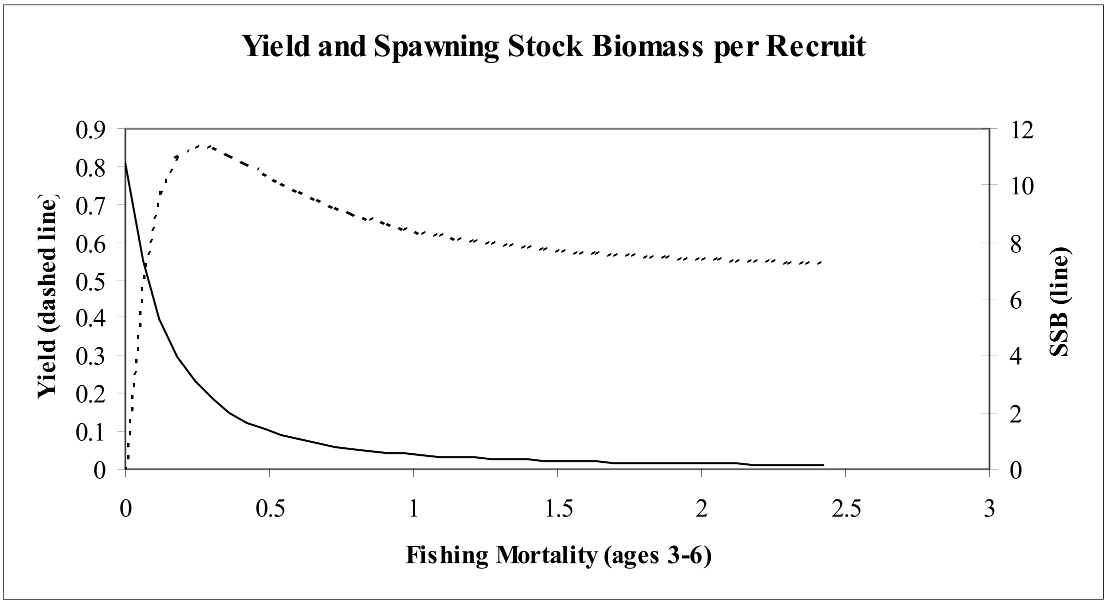


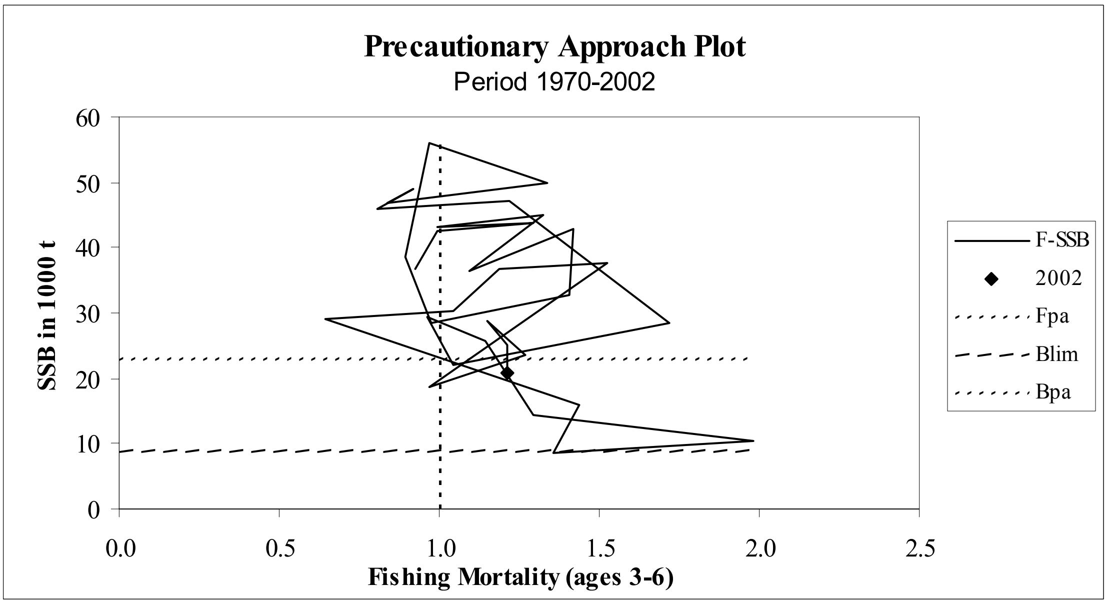







Stock - Recruitment
Recruitment (age 1) in millions
SSB in 1000 t
SSB-Rec.
Blim
Bpa

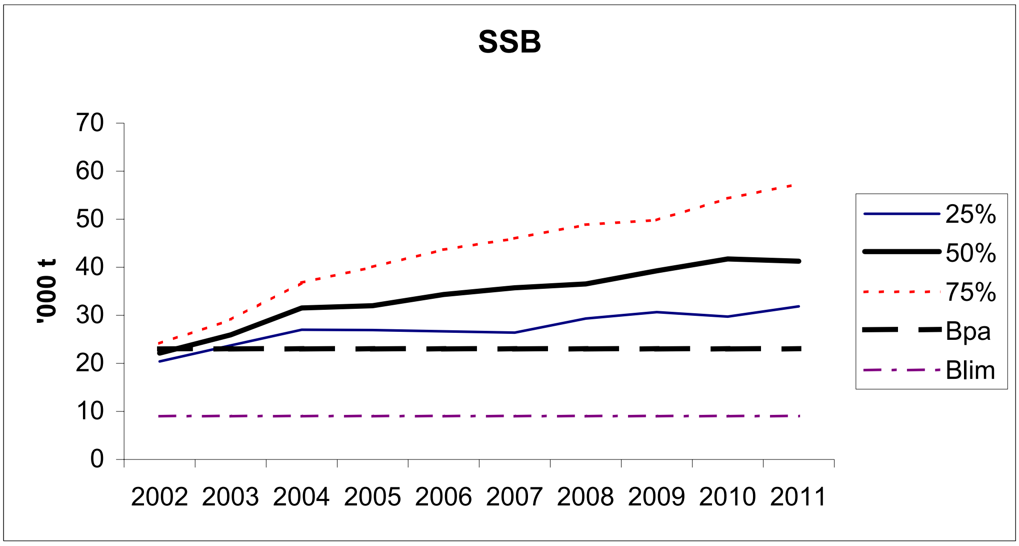

Yield and Spawning Stock Biomass per Recruit
Yield (dashed line)
SSB (line)
Fishing Mortality (ages 3-6)

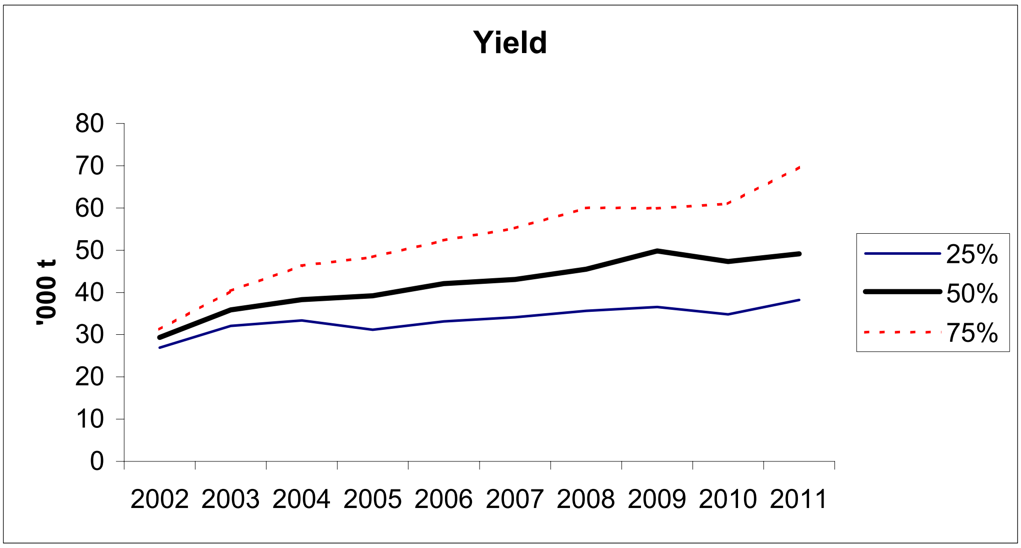

Precautionary Approach Plot
Period 1970-2002
SSB in 1000 t
Fishing Mortality (ages 3-6)
F-SSB
2002
Fpa
Blim
Bpa

Cod in 22-24

Medium term projections

F = Fpa = 1.0





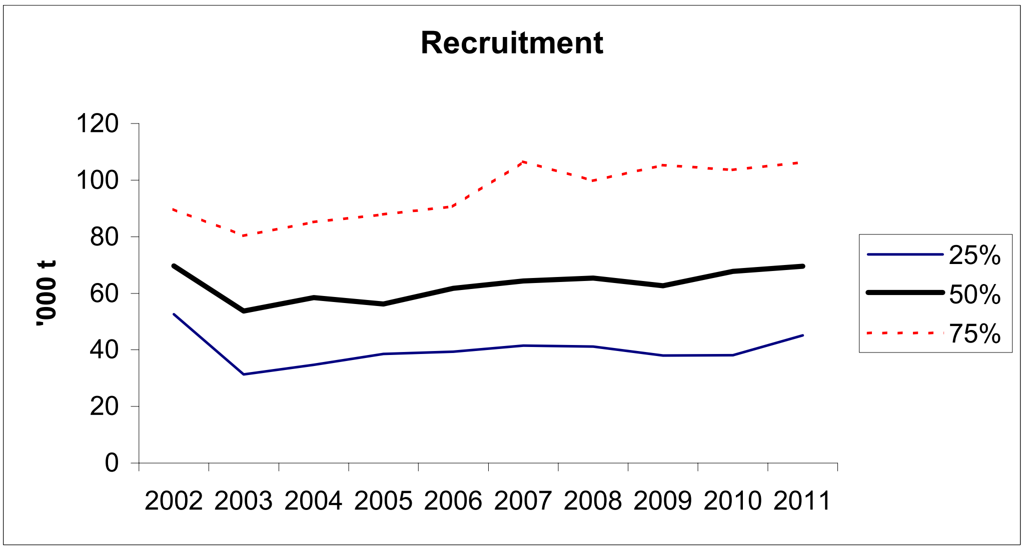


Table 3.14.8.1 Total landings of cod in Subdivisions 22, 23 and 24 (t).

Year	Denmark		Finland	German Dem.Rep.[2]	Germany, Fed. Rep.	Estonia	Latvia	Poland	Sweden	
	23	22+24	24	22+24	22+24	24	24	24	23	24
1965		19,457		9,705	13,350					2,182
1966		20,500		8,393	11,448					2,110
1967		19,181		10,007	12,884					1,996
1968		22,593		12,360	14,815					2,113
1969		20,602		7,519	12,717					1,413
1970		20,085		7,996	14,589					1,289
1971		23,715		8,007	13,482					1,419
1972		25,645		9,665	12,313					1,277
1973		30,595		8,374	13,733					1,655
1974		25,782		8,459	10,393					1,937
1975		23,481		6,042	12,912					1,932
1976	712	29,446		4,582	12,893					1,800
1977	1,166	27,939		3,448	11,686				550	1,516
1978	1,177	19,168		7,085	10,852				600	1,730
1979	2,029	23,325		7,594	9,598				700	1,800
1980	2,425	23,400		5,580	6,657				1,300	2,610
1981	1,473	22,654		11,659	11,260				900	5,700
1982	1,638	19,138		10,615	8,060				140	7,933
1983	1,257	21,961		9,097	9,260				120	6,910
1984	1,703	21,909		8,093	11,548				228	6,014
1985	1,076	23,024		5,378	5,523				263	4,895
1986	748	16,195		2,998	2,902				227	3,622
1987	1,503	13,460		4,896	4,256				137	4,314
1988	1,121	13,185		4,632	4,217				155	5,849
1989	636	8,059		2,144	2,498				192	4,987
1990	722	8,584		1,629	3,054				120	3,671
1991	1,431	9,383			2,879				232	2,768
1992	2,449	9,946			3,656				290	1,655
1993	1,001	8,666			4,084				274	1,675
1994	1,073	13,831			4,023				555	3,711
1995	2,547	18,762	132		9,196		15		611	2,632
1996	2,999	27,946	50		12,018	50	32		1,032	4,418
1997	1,886	28,887	11		9,269	6		263	777	2,525
1998	2,467	19,192	13		9,722	8	13	623	607	1,571
1999	2,839	23,074	116		13,224	10	25	660	682	1,525
2000	2,451	19,876	171		11,572	5	84	926	698	2,564
2001[1)]	2,124	17,446	191		10,579	40	46	646	693	2,479

[1)] Provisional data.

Continued …

Table 3.14.8.1 Continued

Year	Total						
	22	23	24	Unalloc.	22 & 24	22 & 24 & Unalloc.	22-24 & Unalloc.
1965	27,867		17,007		44,874	44,874	44,874
1966	27,864		14,587		42,451	42,451	42,451
1967	28,875		15,193		44,068	44,068	44,068
1968	32,911		18,970		51,881	51,881	51,881
1969	29,082		13,169		42,251	42,251	42,251
1970	31,363		12,596		43,959	43,959	43,959
1971	32,119		14,504		46,623	46,623	46,623
1972	32,808		16,092		48,900	48,900	48,900
1973	38,237		16,120		54,357	54,357	54,357
1974	31,326		15,245		46,571	46,571	46,571
1975	31,867		12,500		44,367	44,367	44,367
1976	33,368	712	15,353		48,721	48,721	49,433
1977	29,510	1,716	15,079		44,589	44,589	46,305
1978	24,232	1,777	14,603		38,835	38,835	40,612
1979	26,027	2,729	16,290		42,317	42,317	45,046
1980	22,881	3,725	15,366		38,247	38,247	41,972
1981	26,340	2,373	24,933		51,273	51,273	53,646
1982	20,971	1,778	24,775		45,746	45,746	47,524
1983	24,478	1,377	22,750		47,228	47,228	48,605
1984	27,058	1,931	20,506		47,564	47,564	49,495
1985	22,063	1,339	16,757		38,820	38,820	40,159
1986	11,975	975	13,742		25,717	25,717	26,692
1987	12,105	1,640	14,821		26,926	26,926	28,566
1988	9,680	1,276	18,203		27,883	27,883	29,159
1989	5,738	828	11,950		17,688	17,688	18,516
1990	5,361	842	11,577		16,938	16,938	17,780
1991	7,184	1,663	7,846		15,030	15,030	16,693
1992	9,887	2,739	5,370		15,257	15,257	17,996
1993	7,296	1,275	7,129	5,528	14,425	19,953	21,228
1994	8,229	1,628	13,336	7,502	21,565	29,067	30,695
1995	16,936	3,158	13,801		30,737	30,737	33,895
1996	21,417	4,031	23,097	2,300	44,514	46,814	50,845
1997	21,966	2,663	18,995		40,961	40,961	43,624
1998	15,093	3,074	16,049		31,142	31,142	34,216
1999	20,409	3,521	18,225		38,634	38,634	42,155
2000	18,934	3,149	16,264		35,198	35,198	38,347
2001[1)]	14,976	2,817	16,451		31,427	31,427	34,244

[1)] Provisional data.

Table 3.14.8.2 Cod in Subdivisions 22 to 24

Year	Recruitment Age 1 thousands	SSB tonnes	Landings tonnes	Mean F Ages 3-6
1970	157127	36748	43959	0.9266
1971	125916	42545	46623	0.9960
1972	172095	43702	48900	1.2948
1973	66253	43138	54357	0.9921
1974	169799	44950	46571	1.3257
1975	87785	36281	44367	1.0962
1976	81450	42845	49433	1.4190
1977	139281	32633	46305	1.4050
1978	104511	28604	40612	0.9733
1979	49961	38667	45046	0.8922
1980	124040	56101	41972	0.9658
1981	90185	49800	53646	1.3404
1982	92464	46931	47524	0.8398
1983	109580	48921	48605	0.9168
1984	35635	46041	49495	0.8058
1985	28150	47280	40159	1.2157
1986	75617	28466	26692	1.7182
1987	43337	22122	28566	1.0438
1988	13726	29292	29159	0.9650
1989	20391	25710	18516	1.1431
1990	18382	14430	17780	1.2918
1991	32247	10422	16693	1.9787
1992	73924	8525	17996	1.3575
1993	41449	15844	21228	1.4361
1994	71380	29002	30695	0.6415
1995	109299	30239	33895	1.0421
1996	17007	36848	50845	1.1903
1997	73162	37552	43621	1.5235
1998	93285	18802	34208	0.9686
1999	46077	23616	42149	1.2712
2000	49165	28645	38357	1.1506
2001	57172	25022	34199	1.2110
2002	68975	20818		1.2109
Average	76934	33047	38505	1.1682

3.14.9 Cod in Subdivisions 25–32

State of stock/exploitation: The stock is outside safe biological limits. Although the actual state of the stock cannot be estimated precisely the available information indicates that SSB in 2002 is well below $\mathbf{B}_{pa}$ and $\mathbf{B}_{lim}$. The fishing mortality is poorly estimated, but is well above $\mathbf{F}_{pa}$. In the most recent years the stock has been below $\mathbf{B}_{lim}$ and the fishing mortality has been fluctuating around $\mathbf{F}_{lim}$. Recruitment since the late 1980s has been below average.

Management objectives: IBSFC have adopted a long-term management strategy for cod in the Baltic (Section 3.14.1) and a cod recovery plan for eastern Baltic cod. For Baltic cod there is one management unit covering all Subdivisions 22–32. ICES considers the stocks in Subdivisions 22–24 and Subdivisions 25–32 as separate stocks, however, and advice is provided on them separately. ICES reiterates its advice that the cod stocks should be managed separately in order to better adapt the exploitation to the present development in the two stocks. With this caveat ICES considers that the agreed management plan may be consistent with the precautionary approach, provided the reductions in F are sufficiently large to allow rapid and secure rebuilding, and that the biomass reference points are used as lower bounds on SSB, and not as targets.

The cod recovery plan states that:

1. For 2002 the fishing mortality for the Eastern stock shall be reduced to below $\mathbf{F}_{pa}$ and shall not be greater than 0.55 within a global TAC of 76 000 tons;

2. Management of the fishery for the Eastern cod stock in year 2003 and subsequent years with the objective of reducing the fishing mortality for the Eastern cod stock to below $\mathbf{F}_{pa}$ is necessary in order to ensure safe and rapid recovery of the spawning stock to levels in excess of 240 000 tons.

In addition the recovery plan establishes a number of technical measures and closures. ICES considers that this recovery plan is consistent with the precautionary approach.

Precautionary Approach reference points (unchanged since 1999):

ICES considers that:	ICES proposes that:
$\mathbf{B}_{lim}$ is 160 000 t	$\mathbf{B}_{pa}$ be set at 240 000 t
$\mathbf{F}_{lim}$ is 0.96	$\mathbf{F}_{pa}$ be set at 0.6

Technical basis:

$\mathbf{B}_{lim}$: SSB below which recruitment is impaired	$\mathbf{B}_{pa}$: MBAL
$\mathbf{F}_{lim}$: Fmed98	$\mathbf{F}_{pa}$: 5 percentile of $\mathbf{F}_{med}$

Advice on management: The state of the stock has not improved since 2001 and the biological justifications for advising no fishing remain. Under the recovery plan fishing mortality in 2003 and subsequent years must be reduced by 70% (F < 0.32) to rebuild the SSB above $\mathbf{B}_{pa}$ in the medium term. Rebuilding of SSB to above $\mathbf{B}_{pa}$ could be slightly faster, if the technical measures improve the exploitation pattern of the fishery. A reduction in F to below 0.10 is necessary in order to rebuild the SSB above $\mathbf{B}_{pa}$ in 3-5 years (depending on the effectiveness of the technical measures at improving the exploitation pattern). The corresponding landings in 2003 for any F depend on whether the new fishing rule will improve the exploitation pattern. Catch options for the scenarios are presented.

Rebuilding plan: This includes TAC restrictions as well as technical measures and seasonal and area closures. The area and seasonal closures are not considered in themselves to be sufficiently effective to achieve rapid and safe rebuilding. Large closed areas and seasons may contribute to stock recovery, but only if accompanied by major reductions in effort or catch. The increases in minimum mesh size in trawls to be introduced during 2002 will help improve the exploitation pattern and reduce discards, but also these measures are not in themselves sufficient to reduce the fishing mortality to the desired level.

Rebuilding the SSB above $\mathbf{B}_{pa}$ in 3-5 years requires a reduction in fishing mortality to below 0.10 in 2003 and subsequent years. If the new fishing rules are effective then the rebuilding period will be shorter.

Relevant factors to be considered in management: In 2001 this stock was below $\mathbf{B}_{lim}$ and ICES advised that no fishing should take place on it. The state of the stock has not improved since 2001 and the biological justifications for advising no fishing remain. However, IBSFC in September 2001 agreed to implement a rebuilding plan, and rebuilding plans may include some fishing, if the exploitation is low enough, and management controls effective enough, to allow safe and rapid rebuilding.

Whether the potential improvement of the exploitation pattern from the new fishing rule will be realized is questioned. It has been observed that technical manipulations of the gear can negate the effectiveness of the new fishing rules. If this practice is widespread the exploitation pattern will not improve.

Cod in the Baltic have traditionally been taken in a directed fishery with very few cod occurring as by-catch in other fisheries. It should therefore be possible for managers to effectively reduce fishing mortality on cod without disrupting fisheries on other species.

There are no indications of substantial movements of fish from this stock to areas outside of Subdivisions 25–32, so management measures do not need to consider migration effects in relation to this stock. However, management measures should consider the possible displacement of effort onto the western Baltic cod stock, where ICES advice is also for a reduction of F in 2002.

Recruitment is influenced not only by the size of the spawning stock, but to a large extent by the environmental conditions (e.g., volume of water with high salinity and high oxygen content). Since the early 1980s fewer and smaller influxes of saline North Sea water were observed than in earlier years. This is reflected in the recruitment pattern, with most recent year classes below the long-term average. It is not possible to predict if and when the present regime of saltwater movements will change. Even though it is not possible to predict these environmental changes precisely, they need to be taken into account in both short-term management and medium-term recovery plans, to ensure that SSB does not become further depleted during the current period of low recruitment, and that rebuilding schedules are realistic. There have been no recent major inflows of saline water to the eastern Baltic, and there are no indications of such an inflow during 2001/2002.

Baltic Cod population dynamics with two well separated stocks indicates that proper management should be based on two separate TACs: one for the western stock (Subdivisions 22-24) and one for the eastern stock (Subdivisions 25-29+32).

Catch forecast for 2003:

No change in selectivity assumed:

Basis: F(2002) = $\mathbf{F}_{sq}$ = F(1998-2001) = 1.05; Landings (2002) = 83.0; SSB(2003) = 87.6.

F (2003)	Basis	Landings (2003)	Discards (2003)	SSB (2004)
0	0	0	0	174.8
0.1	0.1 $\mathbf{F}_{sq}$	11.4	0.3	156.4
0.21	0.2 $\mathbf{F}_{sq}$	22.0	0.6	142.7
0.32	0.3 $\mathbf{F}_{sq}$	31.6	0.9	131.3
0.42	0.4 $\mathbf{F}_{sq}$	40.5	1.1	121.5
0.6	$\mathbf{F}_{pa}$ (0.58 $\mathbf{F}_{sq}$)	54.5	1.6	106.9
0.84	0.8 $\mathbf{F}_{sq}$	69.8	2.1	91.5
1.05	$\mathbf{F}_{sq}$	81.4	2.6	80.4

Weights in '000t.

Shaded scenarios considered inconsistent with the precautionary approach.

Change in selectivity assumed (introduced at start of 2003):

Basis: F(2002) = $\mathbf{F}_{sq}$ = F(1998-2001) = 1.05; Landings (2002) = 83.0; SSB(2003) = 87.6.

F (2003)	Basis	Landings (2003)	Discards (2003)	SSB (2004)
0	0	0	0	174.8
0.09	0.1 $\mathbf{F}_{sq}$	8.9	0	159.6
0.18	0.2 $\mathbf{F}_{sq}$	17.1	0.1	148.7
0.28	0.3 $\mathbf{F}_{sq}$	24.9	0.1	139.7
0.32	0.35 $\mathbf{F}_{sq}$	28.6	0.2	135.7
0.6	$\mathbf{F}_{pa}$ (0.65 $\mathbf{F}_{sq}$)	48.6	0.3	115.7
0.73	0.8 $\mathbf{F}_{sq}$	56.9	0.4	107.9
0.92	$\mathbf{F}_{sq}$	67.2	0.5	98.6

Weights in '000t.

Shaded scenarios considered inconsistent with the precautionary approach.

Medium- and long-term projections: Medium-term projections are necessary to evaluate options for implementing the rebuilding plan agreed to by IBFSC. ICES had serious reservations about the reliability of the point estimates and probabilities from recent assessments, because of concerns about the quality of input data. The medium-term projections must use the point estimates and probabilities from the assessment, and therefore are also highly uncertain. They may provide overly optimistic views of the rebuilding potential of the stock.

Comparison with previous assessment and advice: The current assessment now includes discard data. Fishing mortality has consistently been under-estimated and stock size over-estimated in the previous assessments.

Elaboration and special comment: The catch forecast for 2002 assumes status quo fishing mortality in 2002 or a catch in 2002 of 83 000 t. This is higher than the total TAC for Baltic cod but recent experience with this assessment suggests that the F_{sq} assumption is realistic in terms of generated F. The TAC has not been overshot according to the official statistics in recent years but non-reported catches or landings can be part of this problem.

In recent years catches from eastern Baltic have been approximately 2/3 of the total cod landings.

Age-reading problems and uncertainty in assessing the maturity have resulted in considerable uncertainty about the absolute level of SSB and F. Nevertheless, annual trends, and the perception of the state of the stock with respect to precautionary reference points, are robust to these uncertain data.

Misreporting caused severe problems in the quality of the data in the early 1990s. This is still thought to occur but at a reduced level.

The earlier surveys were not adequately coordinated. Recent work on standardizing surveys has implied that surveys today are coordinated and use similar gears. Calibrations of the historical time series information to the new gear standards add uncertainty to their use as tuning indices.

The landings increased from about 150 000 t in the mid-1970s to around 360 000 t in the early 1980s, but decreased thereafter. The fisheries developed during the 1970s with more fleets entering in the early 1980s, and the intensity of the fishery increased further with the introduction of a gillnet fishery at the end of the 1980s and the beginning of the 1990s. The size of the gillnet fleet has decreased in recent years, and the majority of catches is now taken by mobile gears.

Source of information: Report of the Baltic Fisheries Assessment Working Group, 15 – 24 April 2002 (ICES CM 2002/ACFM:17).

Yield and spawning biomass per Recruit
F-reference points:

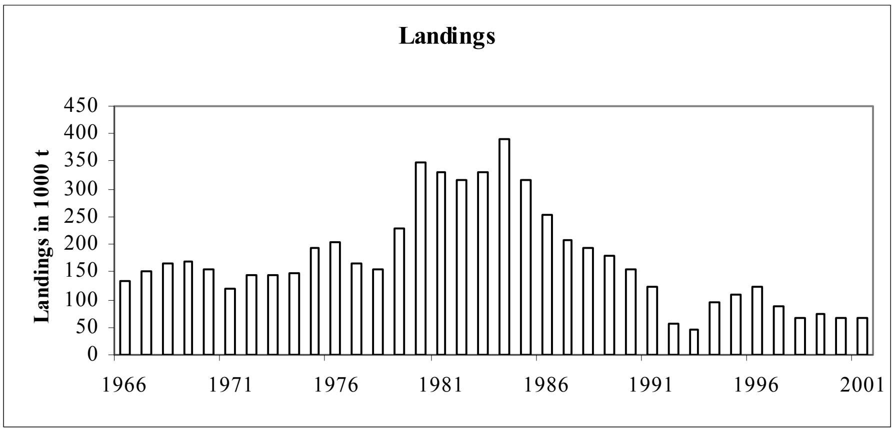
	Fish Mort Ages 4-7	Yield/R	SSB/R
Average Current	1.047	0.606	0.636
$\mathbf{F}_{max}$	0.256	0.808	3.058
$\mathbf{F}_{0.1}$	0.157	0.760	4.615
$\mathbf{F}_{med}$	0.726	0.662	0.955

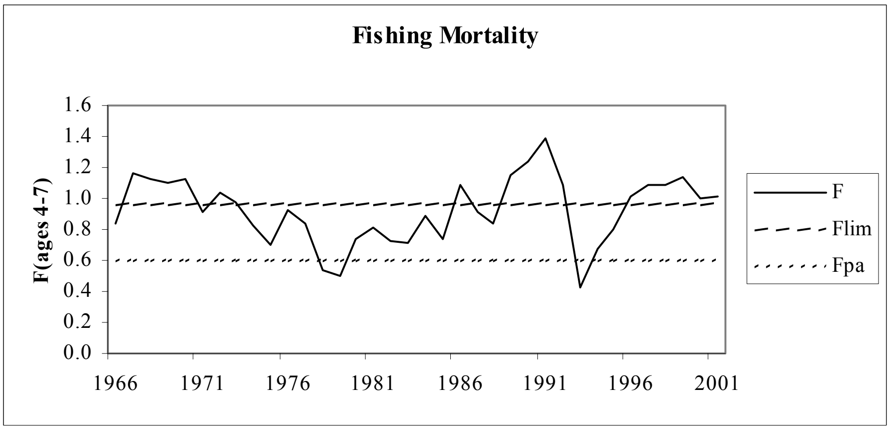
Catch data (Tables 3.14.9.1-2):

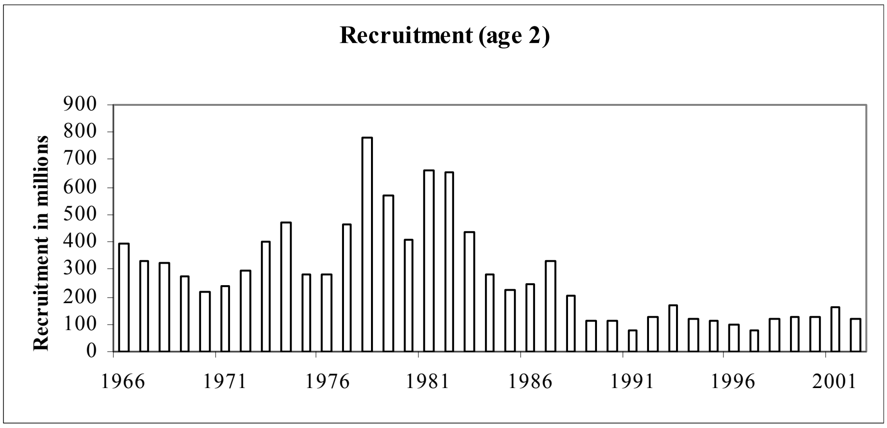
Year	ICES Advice	Predicted catch corresp. to advice	Agreed TAC[1]	ACFM Catch (25–32)	ACFM Catch (22–32)
1987	Reduce towards $\mathbf{F}_{max}$	245		207	236
1988	TAC	150		194	223
1989	TAC	179	220	179	198
1990	TAC	129	210	153	171
1991	TAC	122	171	123	140
1992	Lowest possible level	-	100	55[2]	73[2]
1993	No fishing	0	40	45[2]	66[2]
1994	TAC	25	60	93[2]	124[2]
1995	30% reduction in fishing effort from 1994	-	120	108[2]	142[2]
1996	30% reduction in fishing effort from 1994	-	165	122	173
1997	20% reduction in fishing mortality from 1995	130	180	89	132
1998	40% reduction in fishing mortality from 1996	60	140	67	102
1999	Proposed $\mathbf{F}_{pa}$ (= 0.6)	88	126	72	115
2000	40% reduction in F from 96–98 level	60	105	66	104
2001	Fishing mortality of 0.30	39	105	67.7	102
2002	No fishing	0	76		
2003	70% reduction in F	See option table			

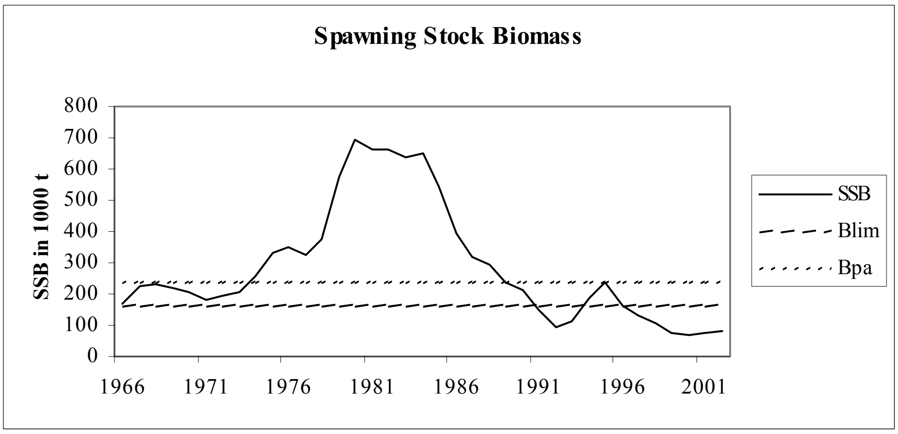
[1]For total Baltic. [2] The reported landings in 1992–1995 are known to be incorrect due to incomplete reporting. Weights in '000 t.

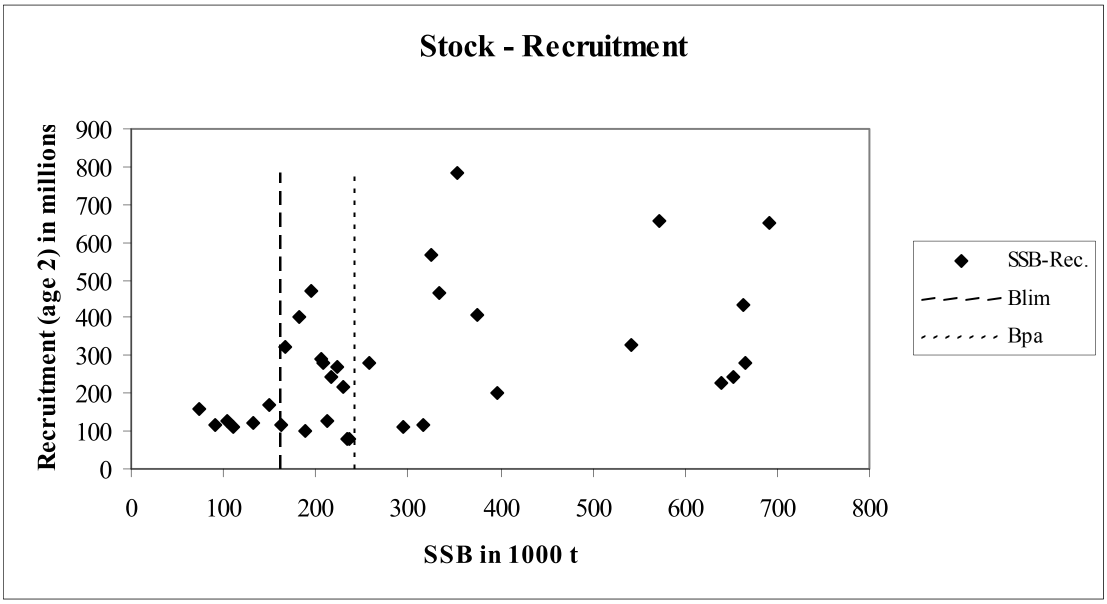
Cod in Subdivisions 25 to 32

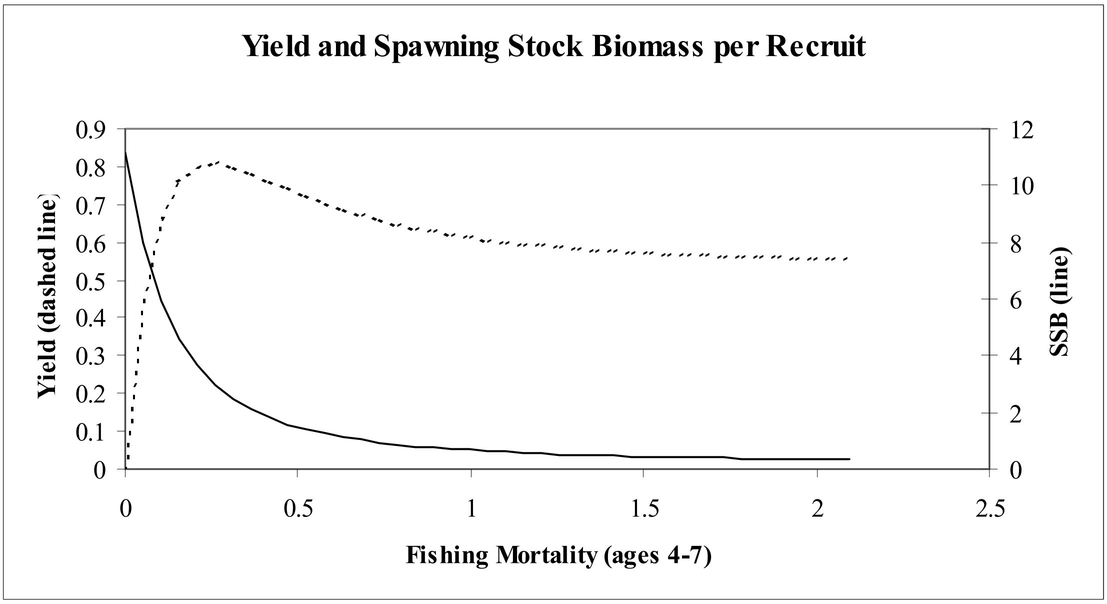









Stock - Recruitment
Recruitment (age 2) in millions
SSB in 1000 t
SSB-Rec.
Blim
Bpa
0
100
200
300
400
500
600
700
800
900


Yield and Spawning Stock Biomass per Recruit
Yield (dashed line)
SSB (line)
Fishing Mortality (ages 4-7)
0
0.5
1
1.5
2
2.5

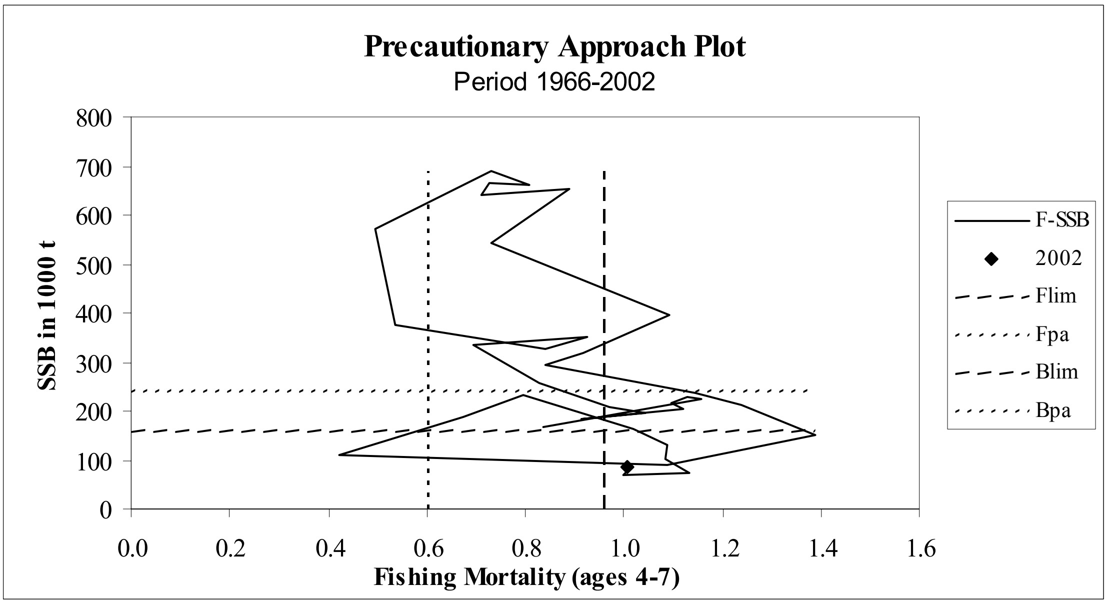

Precautionary Approach Plot
Period 1966-2002
SSB in 1000 t
Fishing Mortality (ages 4-7)
F-SSB
2002
Flim
Fpa
Blim
Bpa

Table 3.14.9.1 Total landings (t) of COD in Subdivisions 25–32 by country.

Year	Denmark	Estonia	Finland	German Dem.Rep.[2]	Germany, Fed. Rep.	Latvia	Lithuania	Poland	Russia	Sweden	USSR	Faroe Islands[4]	Norway	Unallo-cated[3]	Total
1965	15856		23	975	2183			41498		19523	22420				102478
1966	16570		26	2196	1383			56007		20415	38270				134867
1967	19924		27	11020	1057			56003		21367	42980				152378
1968	21516		70	12118	2018			63245		21895	43610				164472
1969	23459		58	18460	4715			60749		20888	41580				169909
1970	22307		70	10103	4855			68440		16467	32250				154492
1971	23116		53	2970	2766			54151		14251	20910				118217
1972	34072		76	4055	3203			57093		15194	30140				143833
1973	35455		95	6034	14973			49790		16734	20083				143164
1974	32028		160	2517	11831			48650		14498	38131				147815
1975	39043		298	8700	11968			69318		16033	49289				194649
1976	47412		287	3970	13733			70466		18388	49047				203303
1977	44400		310	7519	19120			47702		16061	29680				164792
1978	30266		1437	2260	4270			64113		14463	37200				154009
1979	34350		2938	1403	9777			79754		20593	75034	3850			227699
1980	49704		5962	1826	11750			123486		29291	124350	1250			347619
1981	68521		5681	1277	7021			120001		37730	87746	2765			330742
1982	71151		8126	753	13800			92541		38475	86906	4300			316052
1983	84406		8927	1424	15894			76474		46710	92248	6065			332148
1984	90089		9358	1793	30483			93429		59685	100761	6354			391952
1985	83527		7224	1215	26275			63260		49565	78127	5890			315083
1986	81521		5633	181	19520			43236		45723	52148	4596			252558
1987	68881		3007	218	14560			32667		42978	39203	5567			207081
1988	60436		2904	2	14078			33351		48964	28137	6915			194787
1989	57240		2254	3	12844			36855		50740	14722	4520			179178
1990	47394		1731		4691			32028		50683	13461	3558			153546
1991	39792	1810	1711		6564	2627	1865	25748	3299	36490		2611			122517
1992	18025	1368	485		2793	1250	1266	13314	1793	13995		593			54882
1993	8000	70	225		1042	1333	605	8909	892	10099		558		13450	45183
1994	9901	952	594		3056	2831	1887	14335	1257	21264		779		36498	93354
1995	16895	1049	1729		5496	6638	4513	25000	1612	24723		777	293	18993	107718
1996	17549	1338	3089		7340	8709	5524	34855	3306	30669		706	289	8515	121889
1997	9776	1414	1536		5215	6187	4601	31396	2803	25072		600			88600
1998	7818	1188	1026		1270	7765	4176	25155	4599	14431					67428
1999	12170	1052	1456		2215	6889	4371	25920	5202	13720					72995
2000	9715	604	1648		1508	6196	5165	21194	4231	15910					66171
2001[1]	9580	765	1526		2159	6252	3137	21346	5032	17854					67651

[1] Provisional data. [2]Includes landings from Oct.-Dec. 1990 of Fed.Rep.Germany.

[3] Working group estimates. No information available for years prior to 1993. [4] For 1997 landings not officially reported, estimated by the Working Group.

Table 3.14.9.2 Cod in Subdivisions 25 to 32

Year	Recruitment Age 2 thousands	SSB tonnes	Landings tonnes	Mean F Ages 4-7
1966	392574	167655	134867	0.8358
1967	332904	222639	152378	1.1574
1968	320464	228855	164472	1.1289
1969	272324	217804	169909	1.0948
1970	217939	205062	154492	1.1227
1971	242104	181671	118217	0.9119
1972	292775	195547	143833	1.0419
1973	400791	208707	143164	0.9717
1974	471918	258454	147815	0.8296
1975	280924	333519	194649	0.6944
1976	281520	352442	203303	0.9245
1977	463577	324716	164792	0.8423
1978	782245	375328	154009	0.5345
1979	567984	572771	227699	0.4943
1980	405226	691113	347619	0.7329
1981	657536	662796	330742	0.8077
1982	653782	665064	316052	0.7289
1983	434331	639512	332148	0.7112
1984	279926	652353	391952	0.8882
1985	227799	540966	315083	0.7323
1986	244371	396825	252558	1.0921
1987	330244	316802	207081	0.9181
1988	202642	294733	194787	0.8387
1989	114900	237196	179178	1.1461
1990	112431	213308	153546	1.2401
1991	76970	149199	122517	1.3878
1992	128858	91707	54882	1.0872
1993	170594	111354	45183	0.4224
1994	117558	188416	93354	0.6726
1995	113269	234674	107718	0.7956
1996	98936	161682	121889	1.0177
1997	77335	131297	88600	1.0894
1998	117110	103882	67429	1.0837
1999	124122	74349	72989	1.1341
2000	128544	68201	66051	0.9999
2001	160953	76158	67648	1.0079
2002	116137	84238		1.0079
Average	281449	287324	172295	0.9224

Following a recent discussion with DG Fish on the ICES advice on Baltic Cod I have prepared some supplementary catch options for Eastern Baltic cod. The question raised concerns the assumption on the catch in 2002 made by ICES in the forecasts. It has been argued that the catch of 83 000 tons used in the calculations is well above what might be taken even allowing for non-reporting of some catches.

IBSFC informs that catches for the first half of 2002 have been reported as 44,405 tons and that in a normal year this corresponds to 60-65 % of total annual catch. Hence, it is expected that the total for 2002 will be around 75,000 tons corresponding to the TAC of 76,000 tons. IBSFC has no information on the split between the catches taken east and west but based on the split observed in previous years and the present status of the two cod stocks the catch in 2002 for Eastern Baltic cod would be 45-50,000 tons and for Western Baltic cod 25-30,000 tons.

The ACFM Catch Options are based on a catch in 2002 of 29,300 t of Western Baltic Cod and 83,000 t of Eastern Baltic Cod. The catch of eastern Baltic Cod therefore seems to be overestimated.

The reported catch figures are probably underestimates, EU control and inspection has reported on possible non-reported landings but not to the extent that a removal of 83,000 t is likely.

The assessment has suffered from a tendency to overestimate SSB and consequently underestimate the fishing mortality for the most recent year. ICES has investigated this problem and hopes that the changes introduced in the assessment alleviates this problem. Even taking non-reported landings and upward bias in estimated SSB into account, F in 2002 will probably be lower than the assumed F_{sq} of 1.05. Consequently, more cod will survive in 2002 than is indicated.

Based on this information, it appears that management may want to consider other catch options based on different assumed catches for 2002. Therefore, ICES provides three extra catch option tables for eastern Baltic cod based on a catch in 2002 of 50,000 60,000 and 70,000 tons. The tables are for the full implementation of the BACOMA window (or similar improvement in the selectivity) for 2003.

Because of the possible underestimate of fishing mortality it might be prudent to assume that F in 2002 corresponding to a given catch in 2002 will be higher than indicated in the catch option tables.

ICES notes that its advice is unchanged.

ICES also notes that the catch in 2002 has little effect on the trends in SSB indicated by the medium terms prognoses.

Annex II: Effect of 2002 catch on Projection for 2003 for eastern Baltic Cod assuming full effect of selectivity measures in 2003

Eastern Baltic Cod F2003 = 0.6	Landings 2003	SSB 2004
50 000	65.7	140
60 000	60.0	133
70 000	55.0	125
83 000	48.6	115.7

For F_{2003} = 0.6 and full BACOMA selectivity in 2003 other options can be calculated from

Yield (2003) =-0.5156*Catch(2002) + 91.225 ('000 tons)

SSB(2004) = -0.7418*Catch (2002) + 177.2 ('000 tons)

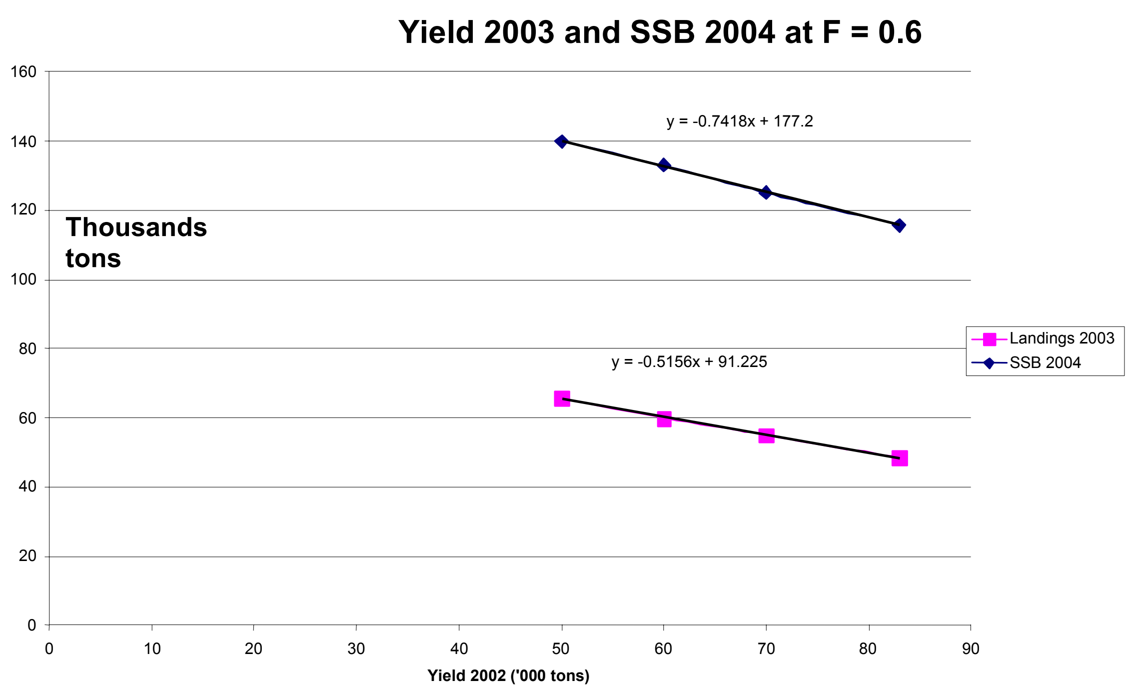
The accuracy is to the nearest 1 000 tons.

Example:

Catch (2002) = 65 000 tons (including allowance for non-reporting)

Yield (2003) = -0.5156*65 + 91.225 = 57.7 ('000 tons)

SSB (2004) = -0.7418* 65 + 177.2 = 129.0 ('000 tons)



Eastern Baltic Cod

Catch Option Tables based on the assumption that the catch of eastern Baltic Cod in 2002 is 50 000, 60 000 or 70 000 tons respectively. All three scenarios are based on the assumption that the measures introduced to improve selectivity will take full in 2003.

Scenario I: Catch Eastern Stock = 50 000 tons Total cod catch 79 300 tons

2002				2003				2004
F-factor	F	SSB	Landing	SSB	F-Factor	F(4-7)	Landing	SSB
0.507893	0.53	84839	50000	119186	0.40	0.367	43959	160806
					0.45	0.413	48626	156447
					0.50	0.459	53134	152252
					0.55	0.505	57489	148213
					0.60	0.551	61698	144325
					0.65	0.597	65766	140580
					0.70	0.642	69699	136972
					0.75	0.688	73503	133496
					0.80	0.734	77182	130146
					0.85	0.780	80743	126917
					0.90	0.826	84188	123803
					0.95	0.872	87524	120800
					1.00	0.918	90754	117904

Scenario II: Catch 2002 Eastern Stock = 60 000 tons Total catch 89 300 tons

2002				2003				2004
F-factor	F	SSB	Landing	SSB	F-Factor	F(4-7)	Landing	SSB
0.638935	0.67	84839	60000	109576	0.40	0.367	40336	151511
					0.45	0.413	44632	147524
					0.50	0.459	48783	143684
					0.55	0.505	52797	139986
					0.60	0.551	56678	136422
					0.65	0.597	60431	132988
					0.70	0.642	64063	129677
					0.75	0.688	67578	126485
					0.80	0.734	70980	123407
					0.85	0.780	74274	120438
					0.90	0.826	77464	117574
					0.95	0.872	80554	114809
					1.00	0.918	83549	112141

Scenario III: Catch 2002 Eastern Stock = 70 000 tons Total catch 99 300 tons

2002				2003				2004
F-factor	F	SSB	Landing	SSB	F-Factor	F(4-7)	Landing	SSB
0.784219	0.82	84839	70000	100068	0.40	0.367	36763	142233
					0.45	0.413	40691	138612
					0.50	0.459	44490	135123
					0.55	0.505	48166	131759
					0.60	0.551	51722	128516
					0.65	0.597	55165	125388
					0.70	0.642	58499	122370
					0.75	0.688	61727	119459
					0.80	0.734	64854	116650
					0.85	0.780	67884	113938
					0.90	0.826	70821	111319
					0.95	0.872	73667	108790
					1.00	0.918	76428	106347

Eastern Baltic Cod Stock - Additional Catch Options

2002	With Selectivity changes in 2003			2003				2004
F-factor	F	SSB	Landing	SSB	F-Factor	F	Landing	SSB
0.507893	0.53	84839	**50000**	119186	0.30	0.275	34120	170045
					0.35	0.321	39126	165336
					0.40	0.367	43959	160806
					0.45	0.413	48626	156447
					0.50	0.459	53134	152252
					0.60	0.551	61698	144325
					0.70	0.642	69699	136972
					0.75	0.688	73503	133496
					0.80	0.734	77182	130146
					0.85	0.780	80743	126917
					0.90	0.826	84188	123803
					0.95	0.872	87524	120800
					1.00	0.918	90754	117904

2002	With Selectivity changes in 2003			2003				2004
F-factor	F	SSB	Landing	SSB	F-Factor	F	Landing	SSB
0.638935	0.67	84839	**60000**	109576	0.30	0.275	31290	159954
					0.35	0.321	35891	155652
					0.40	0.367	40336	151511
					0.45	0.413	44632	147524
					0.50	0.459	48783	143684
					0.60	0.551	56678	136422
					0.70	0.642	64063	129677
					0.75	0.688	67578	126485
					0.80	0.734	70980	123407
					0.85	0.780	74274	120438
					0.90	0.826	77464	117574
					0.95	0.872	80554	114809
					1.00	0.918	83549	112141

2002	No Selectivity changes in 2003			2003				2004
F-factor	F	SSB	Landing	SSB	F-Factor	F	Landing	SSB
0.507893	0.53	84839	**50000**	119186	0.30	0.314	42110	159829
					0.35	0.366	48117	153811
					0.40	0.419	53872	148067
					0.45	0.471	59385	142584
					0.50	0.523	64669	137347
					0.60	0.628	74593	127568
					0.70	0.732	83722	118640
					0.75	0.785	88011	114470
					0.80	0.837	92129	110482
					0.85	0.889	96083	106669
					0.90	0.942	99881	103022
					0.95	0.994	103529	99533
					1.00	1.046	107035	96194

2002	No Selectivity changes in 2003			2003				2004
F-factor	F	SSB	Landing	SSB	F-Factor	F	Landing	SSB
0.638935	0.67	84839	**60000**	109576	0.30	0.314	38917	150282
					0.35	0.366	44479	144736
					0.40	0.419	49811	139439
					0.45	0.471	54923	134379
					0.50	0.523	59825	129545
					0.60	0.628	69038	120510
					0.70	0.732	77524	112252
					0.75	0.785	81516	108391
					0.80	0.837	85349	104698
					0.85	0.889	89033	101164
					0.90	0.942	92572	97781
					0.95	0.994	95975	94544
					1.00	1.046	99247	91444

3.14.10 Flounder

State of stock/exploitation: The total landings of flounder were quite stable from the early 1970s until 1994, when reported landings increased markedly. Reported catches in 1995 and 1996 were well above the previous average, but have decreased thereafter. The 2001 landings were the highest observed.

Results from a tentative assessment of the stock in Subdivisions 24 and 25 suggest a downward trend of the spawning stock since the late 1970s.

Comparison with previous assessment and advice: The tentative assessment shows the same trends as last years assessment.

Elaboration and special comment: Flounder is taken as a by-catch in the cod trawl and gillnet as well as in coastal fisheries. There are also directed trawl fisheries for this species in Subdivisions 24 and 25. For 1994–1998 high total landings of flounder were recorded, likely due to misreporting of other fish species as flounder (Table 3.14.10.1).

The majority of the landings are caught in Subdivisions 24, 25 and 26. The amount of discarded flounder is not known, but it is assumed to be high.

Source of information: Report of the Baltic Fisheries Assessment Working Group, 15 – 24 April 2002 (ICES CM 2002/ACFM:17).

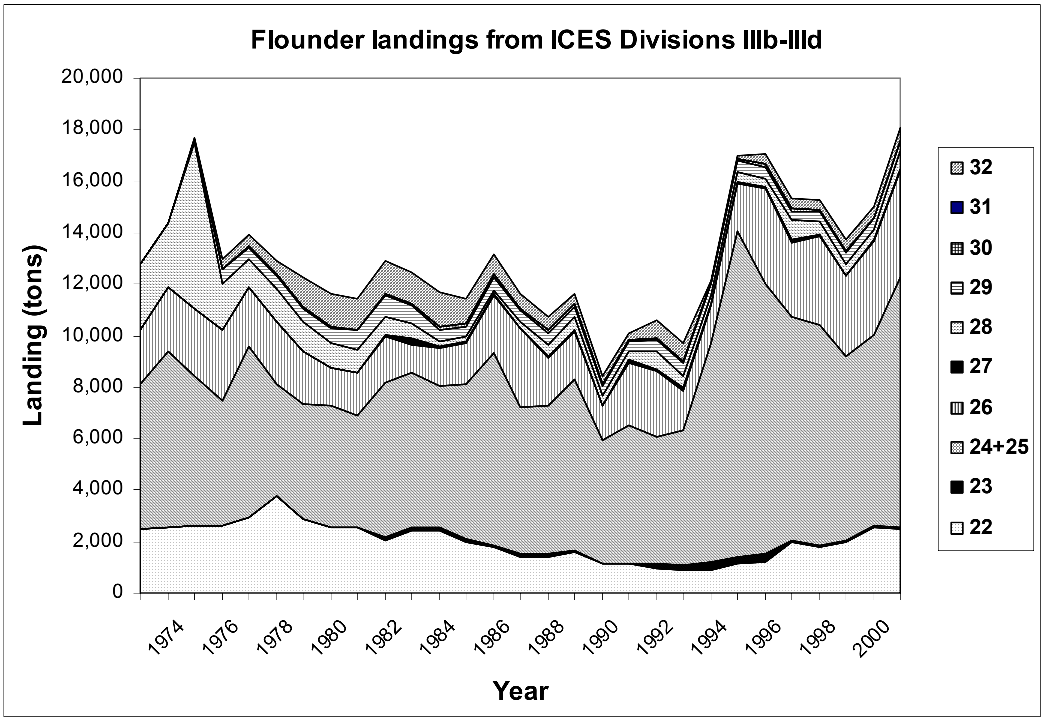


Table 3.14.10.1 Total landings (tons) of FLOUNDER in the Baltic by sub-division and country.(There are some gaps in the information. Therefore "Total" is preliminary.)

Year	Denmark[1]					Finland					German Dem. Rep.[2]			Germany, Fed. Rep.				Poland		Sweden[3]							
	22	23	24.25	26	28(29)	24	25	29[6]	30[7]	32	22	24	25(+26)	22	24(+25)	26	28	25(+24)	26	22	23	24	25	26	27	28	29
1973	1,983		386								181	1,624	1,516	349	4			1,580	2,070				502				
1974	2,097		2,578								165	1,482	654	304	3			1,635	2,473				470				
1975	1,992		1,678					113	22	47	163	1,469	406	469	1			1,871	2,585				400				
1976	2,038		482					118	23	59	174	1,556	901	392	2			1,549	2,289				400				
1977	1,974		389					115	32	56	555	2,708	1,096	393	4			2,071	2,089				416				
1978	2,965		415					174	61	155	348	2,572		477	1			996	2,106				346				
1979	2,451		405					192	54	153	189	2,509		259	3			1,230	1,860				315				
1980	2,185		286					194	69	165	138	2,775		212	1			1,613	1,380			16	46		20	181	32
1981	1,964		548					227	56	135	271	2,595		351	1			1,151	1,541			21	30		21	194	34
1982	1,563	104	257					219	58	144	263	3,202		248	1			2,484	1,623			22	33		65	16	3
1983	1,714	115	450					181	67	120	280	3,572		418	1			1,828	905			72	108		212	52	9
1984	1,733	85	306					174	108	135	349	2,719		371	1			2,471	1,288			18	27		53	13	2
1985	1,561	130	649					157	97	137	236	3,253		199	4			2,063	1,302			16	24		47	12	2
1986	1,525	65	1,558					199	128	181	127	2,838		125	10			3,030	1,784			20	31		60	15	3
1987	1,208	122	1,007					159	106	143	71	2,096		114	11			2,530	1,745			17	26		51	13	2
1988	1,162	125	990					177	118	159	92	2,981		133	5			1,728	1,292			23	35		68	17	3
1989	1,321	83	1,062					175	122	163	126	3,616		122	2			1,896	1,089			22	34		66	16	3
1990	941		1,389					219	81	161	52	1,622		183	10			1,617	599				120				
1991	925		1,497					236	81	167				246	1,814			2,008	1,905			24	31		88	20	
1992	713	185	975					405	40	627				227	1,972			1,877	1,869			41	88	3	86	11	3
1993	649	194	635					438	57	683				235	1,230			3,276	1,229		26	27	63	1	83	10	
1994	882	181	1,016					445	33	87				44	4,262	2	3	3,177	1,266		84	20	18	37	33	55	10
1995	859	231	2,110					398	28	131				286	2,825	4	40	7,437	1,482		58	28	186	7	81	18	
1996	1,041	227	2,306				1	365	78	271				189	1,322	10	9	6,069	2,556	2	58	101	718	48	114	31	
1997	1,356		2,421	31	10		1	283	69	299				655	1,982	12	4	3,877	1,730		42	62	308	31	105	370	
1998	1,372		2,393				4	284	59	297				411	1,729	2		4,215	1,370		61	49	187	18	70	117	
1999	1,473		1,206				1	286	57	276				510	1,825			4,015	1,435		37	24	87	47	15		
2000	1,896		1,757			15	6	276	43	275				660	2,089			3,423	1,668		41	49	122		73	28	
2001[5]	2,030		3,048			9	69	224	28	267				458	1,886			4,608	1,433		52	31	96	3	90	178	

continued

Table 3.14.10.1 Continued

Year	USSR				Estonia					Latvia			Lithuania[8]		Russia		Total							
	26	28	29	32	25	26	28	29	32	25	26	28	25	26	26	28	22	23[1]	24	25[4]	26	27	28	29
1973		2610															2,513		2,014	3,598	2,070		2,610	
1974		2510															2,566		4,063	2,759	2,473		2,510	
1975		6455															2,624		3,148	2,677	2,585		6,455	113
1976	471	1779	409	359													2,604		2,040	2,850	2,760		1,779	527
1977	210	1081	321	414													2,922		3,101	3,583	2,299		1,081	436
1978	288	1290	334	395													3,790		2,988	1,342	2,394		1,290	508
1979	158	1170	330	1012													2,899		2,917	1,545	2,018		1,170	522
1980	93	798	334	1080													2,535		3,078	1,659	1,473	20	979	560
1981	58	742	445	1078													2,586		3,165	1,181	1,599	21	936	706
1982	195	665	615	1121													2,074	104	3,482	2,517	1,818	65	681	837
1983	209	551	497	1114													2,412	115	4,095	1,936	1,114	212	603	687
1984	145	202	286	1226													2,453	85	3,044	2,498	1,433	53	215	462
1985	268	189	265	806													1,996	130	3,922	2,087	1,570	47	201	424
1986	442	159	281	556													1,777	65	4,426	3,061	2,226	60	174	483
1987	1315	203	279	397													1,393	122	3,131	2,556	3,060	51	216	440
1988	578	439	257	331													1,387	125	3,999	1,763	1,870	68	456	437
1989	783	512	214	214													1,569	83	4,702	1,930	1,872	66	528	392
1990	752	390	144	141													1,176		3,021	1,737	1,351		390	363
1991						49	1	135	51		123	323		125	216	10	1,171		3,335	2,039	2,418	88	354	371
1992							47	47	46		26	664		483	146		940	185	2,988	1,965	2,527	86	722	455
1993							52	86	55		99	389			225		884	220	1,892	3,339	1,554	83	451	524
1994								3	4		31	276			167		926	265	5,298	3,195	1,503	33	334	458
1995					8		16	52	35		39	322	8	53	271		1,145	289	4,963	7,639	1,856	81	396	450
1996							44	99	145		74	215		231	740		1,232	285	3,729	6,788	3,659	114	299	464
1997					15		101	96	125		78	284			1,001		2,011	42	4,465	4,201	2,883	105	769	379
1998					10		146	79	87	2	88	274		737	1,188		1,783	61	4,171	4,418	3,403	70	537	363
1999					8		92	150	164		140	365		547	964		1,983	37	3,055	4,111	3,133	15	457	436
2000					2	1	65	150	126	3	113	302		575	1,236		2,556	41	3,910	3,556	3,593	73	395	426
2001[5]							100	161	221		201	412		1,127	1,355		2,488	52	4,974	4,773	4,119	90	690	385

[1] For the years 1973-1981 the catches of Subdivision 23 are included in Subdivision 22.
[2] From October-December 1990 landings of Germany, Fed. Rep. are included.
[3] For the years 1973-1979 and 1990 the catches of Subdivisions 24-29 are included in Subdivision 25.
[4] For the years 1973-1979 and 1990 the Swedish catches of Subdivisions 24-29 are included in Subdivision 25.
[5] Provisional.
[6] Landings of Subdivision 27 are included
[7] Landings of Subdivision 31 are included
[8] Lithuania, for 1993, 1994, 1997 and 1998 no data reported

[1] For the years 1973-1981 the catches of Sub-division 23 are included in Sub-di
[2] From October-December 1990 landings of Germany, Fed. Rep. are included.
[3] For the years 1973-1979 and 1990 the catches of Sub-divisions 24-29 are included in Sub-
[4] For the years 1973-1979 and 1990 the Swedish catches of Sub-divisions 24-29 are included in Sub
[5] Provisiona
[6] Landings of Sub-division 27 are inclu
[7] Landings of Sub-division 31 are included
[8] Lithuania, for 1993, 1994, 1997 and 1998 no data rep

3.14.11 Plaice

State of stock/exploitation: The available data are insufficient for assessing the current stock size and exploitation.

Elaboration and special comment: Subdivisions 22 and 24 are the most important areas for plaice fishery in the Baltic. The total landings of plaice (Table 3.14.11.1) were high in the 1970s, but have decreased since the 1980s to the lowest on record in 1993 (269 t). Since then the landings have increased above 2 500 t, mainly due to increased landings from Subdivision 22.

Source of information: Report of the Baltic Fisheries Assessment Working Group, 15 – 24 April 2002 (ICES CM 2002/ACFM:17).

Plaice in Subdivisions 22 to 32

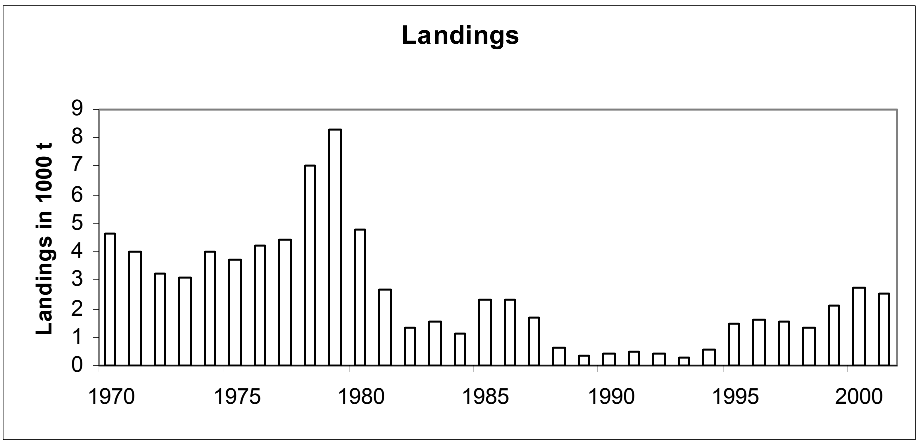


Table3.14.11.1 Total landings (tonnes) of PLAICE in the Baltic by subdivision and country.
(There are some gaps in the information. Therefore "Total" is preliminary.)

Year	Denmark			Germ.Dem. R.[1]		Germany, Fed. Rep.				Poland		Sweden[2]							
	22	23	24(25)	22	24	22	24(+25)	26	28	25(+24)	26	22	23	24	25	26	27	28	29
1970	3,757		494			202	16							149					
1971	3,435		314			160	2							107					
1972	2,726		290			154	2							78					
1973	2,399		203	2	44	163	1			174	30			75					
1974	3,440		126	36	10	166	2			114	86			60					
1975	2,814		184	11	67	302	1			158	142			45					
1976	3,328		178	11	82	302	3			164	76			44					
1977	3,452		221	5	36	348	2			265	26			41					
1978	3,848		681	33	1,198	346	3			633	290			32					
1979	3,554		2,027	10	1,604	195	7			555	224			113					
1980	2,216		1,652	5	303	84	5			383	53			113					
1981	1,193		937	6	52	74	31			239	27			118					
1982	716		393	6	25	39	6			43	64			40	6		7	1	
1983	901		297	5	12	37	14			64	12			133	20		24	2	
1984	803		166	7	2	23	8			106				23	3		4	1	
1985	648		771	68	593	26	40			119	49			25	4		5	1	
1986	570		1,019	34	372	25	7			171	59			48	7		9	1	
1987	414		794	4	142	14	16			188	5			68	10		12	1	
1988	234		323	3	16	7	1			9	1			49	7		9	1	
1989	167		149		5	7				10				34	5		6	1	
1990	236		100		1	9	1			6				50					
1991	328		112			15	9			2	1			5	2		2		
1992	316		74			11	4			6				3	1		1		
1993	171		66			16	6			4			2	4					
1994	355		159			1				43	4		6	4	7				
1995	601	64	343			75	91		1	233	2		12	13	10	1			
1996	859	81	263			43	77			183	5	1	13	28	23	10	1		
1997	902		201			51	56			308	3		13	7	8		1		
1998	642		278			213	41			101	14		13	6	17		1		
1999	1,456		183			244	46			145	1	1	13	5	10				
2000	1,932		161			140	37			408	3		26	9	12				
2001 [4]	1,627		173			58	43			549	3		39	9	13				

continued

Table 3.14.11.1 continued

Year	Total								Total
	22	23	24[3]	25	26	27	28	29	22-29
1970	3,959		659						4,618
1971	3,595		423						4,018
1972	2,880		370						3,250
1973	2,564		323	174	30				3,091
1974	3,642		198	114	86				4,040
1975	3,127		297	158	142				3,724
1976	3,641		307	164	76				4,188
1977	3,805		300	265	26				4,396
1978	4,227		1,914	633	290				7,064
1979	3,759		3,751	555	224				8,289
1980	2,305		2,073	383	53				4,814
1981	1,273		1,138	239	27				2,677
1982	761		464	49	64	7	1		1,346
1983	943		456	84	12	24	2		1,521
1984	833		199	109		4	1		1,146
1985	742		1,429	123	49	5	1		2,349
1986	629		1,446	178	59	9	1		2,322
1987	432		1,020	198	5	12	1		1,668
1988	244		389	16	1	9	1		660
1989	174		188	15		6	1		384
1990	245		152	6					403
1991	343		126	4	1	2			476
1992	327		81	7		1			416
1993	187	2	76	4					269
1994	356	6	163	50	4				579
1995	676	76	447	243	3		1		1,446
1996	903	94	368	206	15	1			1,587
1997	953	13	264	316	3	1			1,550
1998	855	13	325	118	14	1			1,326
1999	1,701	13	234	155	1				2,104
2000[4]	2,072	26	207	420	3				2,728
2001	1,685	39	225	562	3				2,514

[1] From October-December 1990 landings of Germany, Fed. Rep. are included.

[2] For the years 1970-1981 and 1990 the catches of Subdivisions 25-28 are included in Subdivision 24.

[3] For the years 1970-1981 and 1990 the Swedish catches of Subdivisions 25-28 are included in Subdivision 24.

[4] Provisional.

3.14.12 Dab

State of stock/exploitation: The available data are insufficient for assessing the current stock size and exploitation.

Elaboration and special comment: The total landings of dab (Table 3.14.12.1) were stable at around 2 000 t per year in the 1980s and the early 1990s. The reported catches in 1994 and 1995 increased to 3 000 t, but in 1996 they returned to the previous level. From 1997 onwards the landings decreased and in 2000 and 2001 are on the lowest level (850-900 t).

The temporary increase in landings reported for 1994 and 1995 is influenced by misreporting of other species as dab.

Most catches were taken from Subdivision 22 (90-91% of total landings), followed by Subdivision 24 with only up to 7-9% of the total landings.

Source of information: Report of the Baltic Fisheries Assessment Working Group, 15 – 24 April 2002 (ICES CM 2002/ACFM:17).

Dab in Subdivisions 22 to 32

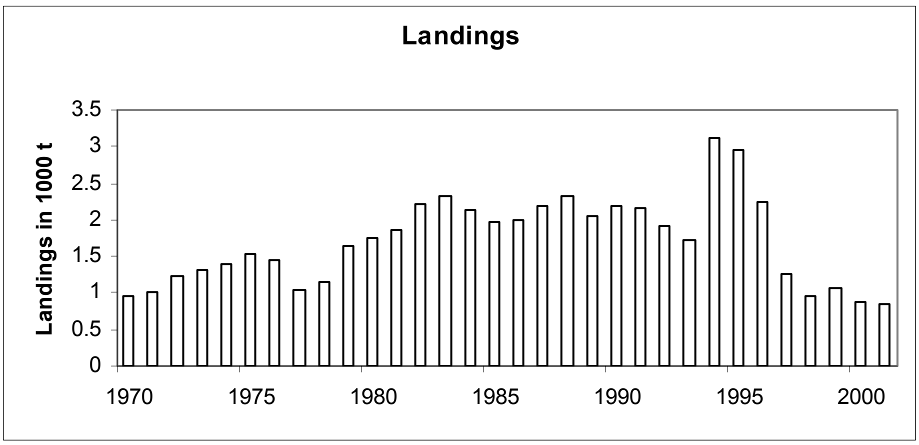


Table 3.14.12.1 Total landings (tonnes) of DAB in the Baltic by Subdivision and country. (There are some gaps in the information. Therefore "Total" is preliminary.)

Year	Denmark				G. Dem. Rep.[1]		Germany, Fed. Rep.				Sweden[2]								Total									Total
	22	23	24(+25)	25-28	22	24	22	24	25	26	22	23	24	25	27	28	29	30	22	23	24[3]	25[5]	26	27	28	29	30	22-30
1970	845		20		11		74												930		20							950
1971	911		26		10		64												985		26							1,011
1972	1110		30		9		63						23						1,182		53							1,235
1973	1087		58		18		118						30						1,223		88							1,311
1974	1178		51		18		118						34						1,314		85							1,399
1975	1273		74		20		131						32						1,424		106							1,530
1976	1238		60		17		114						27						1,369		87							1,456
1977	889		32		13		89						25						991		57							1,048
1978	928		51		19	14	128	4											1,075		69							1,144
1979	1413		50		18	25	123	1					9						1,554		85							1,639
1980	1593		21		15	25	101						3						1,709		49							1,758
1981	1601		32		24	39	164						5						1,789		76							1,865
1982	1863		50		46	38	182	4					6	5	8	6		1	2,091		98	5		8	6		1	2,209
1983	1920		42		46	28	198						24	20	32	22		2	2,164		94	20		32	22		2	2,334
1984	1796		65		30	47	175	2					4	3	5	4		1	2,001		118	3		5	4		1	2,132
1985	1593		58		52	51	187	2					3	3	5	3		1	1,832		114	3		5	3		1	1,958
1986	1655		85		36	35	185	1					1	1	1	1			1,876		122	1		1	1			2,001
1987	1706		93		14	87	276	4					1	1	1	1			1,996		185	1		1	1			2,184
1988	1846		75		22	91	281	1					1	1	1	1			2,149		168	1		1	1			2,320
1989	1722		48		26	19	218	1					1	1	2	1			1,966		69	1		2	1			2,039
1990	1743		146		14	11	252	1					8						2,009		166							2,175
1991	1731		95				340	5					1						2,071		101							2,172
1992	1406		81				409	6						1	1		4		1,815		87	1		1		4		1,908
1993	996		155				556	10				7	1	1			1		1,552	7	166	1				1		1,727
1994	1621		163				1190	80	45			5	1	1					2,811	5	244	46						3,106
1995	1510	47	127	10			1185	49	3			5	1	5		1			2,695	52	177	18			1			2,943
1996	913	37	128				991	134	13	2	3		3	4	1				1,907	37	265	17	2	1				2,229
1997	728		60				413	21	2			5	5	10	3	1			1,141	5	86	12		3	1			1,248
1998	569		89				280	6	2			7	3	3	1				849	7	98	5		1				960
1999	664		59				339	4				3	1	1					1,003	3	64	1						1,071
2000	612		46				212	3				2		1					824	2	49	1						876
2001 [1]	586		72				191	5				4	1	2					777	4	78	2						861

[1] From October-December 1990 landings of Germany, Fed. Rep. are included.
[2] For the years 1970-1981 and 1990 the catches of Subdivisions 25-28 are included in Subdivision 24.
[3] For the years 1970-1981 and 1990 the Swedish catches of Subdivisions 25-28 are included in Subdivision 24.
[4] Provisional.
[5] In 1995 Danish landings of Subdivisions 25-28 are included.

3.14.13 Turbot

State of stock/exploitation: The available data are insufficient for assessing the current stock size and exploitation.

Elaboration and special comment: The landings of turbot in the Baltic increased from less than 100 t in the 1960s and 1970s to nearly 500 t in the early 1990s, and again to above 1 000 t in the mid-1990s. Catches declined after 1996, and are now about 500 t (Table 3.14.13.1).

The main turbot fishery takes place in Subdivisions 22, 24, 25, 26, and 28. Due to the high market demand a directed turbot gillnet fishery developed in the 1990s.

At present the IBSFC regulations of the turbot fishery are minimum landing size and a temporary closure of fishing during the spawning season. There are also additional national regulations, for example, a minimum mesh size for some fisheries.

Although there are ongoing study programs in several countries focusing on the status of turbot stocks in the Baltic, the data available are insufficient to allow evaluation of the appropriateness of the present management measures in respect to the precautionary approach.

The landings are uncertain due to incomplete reporting, especially for the early years.

Source of information: Report of the Baltic Fisheries Assessment Working Group, 15 – 24 April 2002 (ICES CM 2002/ACFM:18).

Turbot in Subdivisions 22 to 32

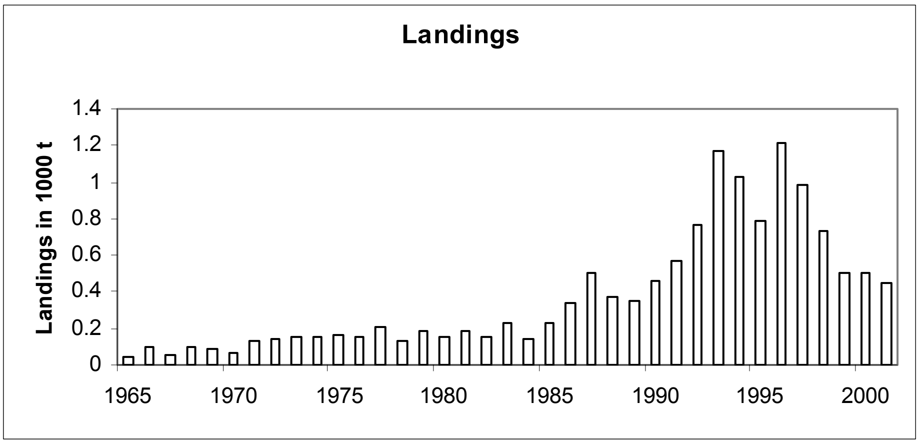


Table 3.14.13.1 Total landings (tonnes) of TURBOT in the Baltic by Subdivision and country**.**(There are some gaps in the information. Therefore "Total" is preliminary.)

Year	Denmark			Germ. Dem.R.[1]		Germany, Fed. Rep.						Poland		Sweden[2]							Latvia		Lithuania[5]	Russia
	22	23	24(25)	22	24	22	24	25	26	27	28	25(+24)	26	22	23	24	25	26	27	28(+29)	26	28	26	26
1966	16		21	5	53																			
1967	14		20	7	10																			
1968	14		18	3	67																			
1969	13		13	4	57																			
1970	11		13	5	40											2								
1971	11		26	4	86											2								
1972	10		26	3	100											3								
1973	11		30	3	33							58	13			5								
1974	14		40	2	23							34	36			6								
1975	27		48	3	38	15						23	6			7								
1976	29		24		52	11						14	12			7								
1977	32		37		55	9						12	55			8								
1978	33		37	2	27	9						7	3			10								
1979	23		38	3	39	6						29	34			12								
1980	28		38		30	9						12	20			15								
1981	28		62	1	46	8						10	19			7								
1982	31		51	1	27	7						2	17			3	4		4	3				
1983	33		40	3	9	8						5	4			31	41		35	24				
1984	41		45	4	8	12						13	2			3	4		3	2				
1985	56		34	5	22	15						67	15			4	5		4	3				
1986	99		81	6	32	25						32	37			6	8		7	5				
1987	134		93	4	34	30						155	21			8	11		9	6				
1988	117		117	3	28	34						7	10			12	16		14	9				
1989	135		109	7	22	20							11			11	15		13	9				
1990	178		181	4	2	26						24	25			14								
1991	228		137			44	39					73	20			2	12		16					
1992	267		127			55	68					80	55			12	12		21	36				30
1993	159	29	152			74	56					520	72		2	4	14		13	38				34
1994	211	18	166			52	57	10				380	30		2	3	18	1	17	44				15
1995	257	11	94			65	53	4				30	15		2	3	54	9	31	83	34	27		20
1996	207	12	95			36	47	4		1		288	92	1	3	15	100	5	54	104	42	3	76	25
1997	151		68			60	52	3				290	70		2	6	70	1	53	86	33	14		25
1998	138		80			44	55	1				66	68		2	4	58	1	18	69	12	24		96
1999	106		59			23	48					18	15		2	4	41	3	17	60	20	34		48
2000	97		58			23	54					90	12		2	3	39		16	39	7	9		53
2001[4]	76		53			19	31					121	10		2	5	16		9	29	5	1		69

Table 3.14.13.1 continued

Year	Total	Total

	22	23	24[3]	25	26	27	28(+29)	22-28(+29)
1965	3		39					42
1966	21		74					95
1967	21		30					51
1968	17		85					102
1969	17		70					87
1970	16		55					71
1971	15		114					129
1972	13		129					142
1973	14		68	58	13			153
1974	16		69	34	36			155
1975	45		93	23	6			167
1976	40		83	14	12			149
1977	41		100	12	55			208
1978	44		74	7	3			128
1979	32		89	29	34			184
1980	37		83	12	20			152
1981	37		115	10	19			181
1982	39		81	6	17	4	3	150
1983	44		80	46	4	35	24	233
1984	57		56	17	2	3	2	137
1985	76		60	72	15	4	3	230
1986	130		119	40	37	7	5	338
1987	168		135	166	21	9	6	505
1988	154		157	23	10	14	9	367
1989	162		142	15	11	13	9	352
1990	208		197	24	25			454
1991	272		178	85	20	16		571
1992	322		207	92	85	21	36	763
1993	233	31	212	534	106	13	38	1,167
1994	263	20	226	408	46	17	44	1,024
1995	322	13	150	88	78	31	110	792
1996	244	15	157	392	240	55	107	1,210
1997	211	2	126	363	129	53	100	984
1998	182	2	139	125	177	18	93	736
1999	129	2	111	59	86	17	94	498
2000	120	2	115	129	72	16	48	502
2001[4]	95	2	89	137	84	9	30	446

[1] From October-December 1990 landings of Germany, Fed. Rep. are included

[2] For the years 1970-1981 and 1990 the catches of Subdivisions 25-28 are included in Subdivision 24

[3] For the years 1970-1981 and 1990 the Swedish catches of Subdivisions 25-28 are included in Subdivision 24

[4] Provisional.

[5]Lithuania, for 1995,1997,1998,1999 and 2000 no data reported

3.14.14 Brill

State of stock/exploitation: The available data are insufficient for assessing the current stock size and exploitation.

Elaboration and special comment: The landings of brill in the Baltic are low and are typically less than 50 t (Table 3.14.14.1) and are mainly taken in Subdivision 22.

The reported total landings of brill, especially in 1994-1996 are overestimated due to the misreporting of species in the landings of the directed cod fishery.

Source of information: Report of the Baltic Fisheries Assessment Working Group, 15 – 24 April 2002 (ICES CM 2002/ACFM:17).

Brill in Subdivisions 22 to 32

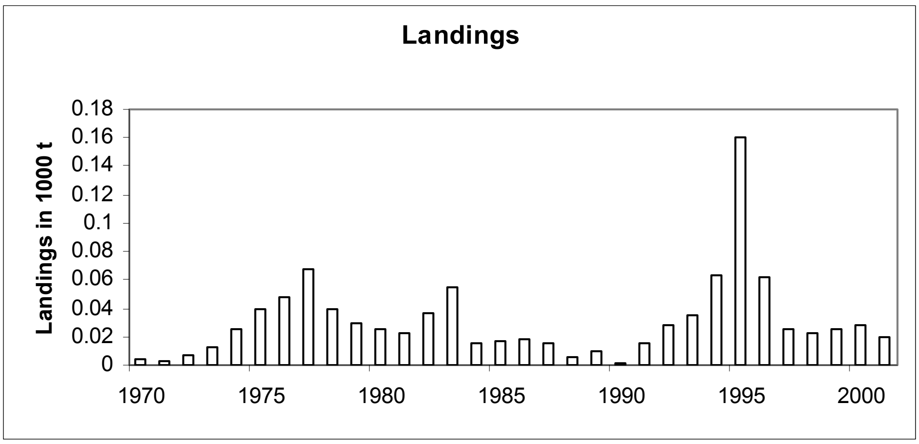


Table 3.14.14.1 Total landings (tonnes) of BRILL in the Baltic by subdivision and country.
(There are some gaps in the information. Therefore "Total" is preliminary.)

Year	Denmark			Germany Fed. Rep.	Sweden		Total			Total 22-28
	22	23	24-28	22	23	24-28	22	23	24-28	
1970	4						4			4
1971	3						3			3
1972	7						7			7
1973	11		2				11		2	13
1974	25		1				25		1	26
1975	38		1	1			39		1	40
1976	45		1	2			47		1	48
1977	60		2	5			65		2	67
1978	37			3			40			40
1979	30						30			30
1980	26						26			26
1981	22			1			23			23
1982	19					17	19		17	36
1983	13					42	13		42	55
1984	12					3	12		3	15
1985	16					1	16		1	17
1986	15					3	15		3	18
1987	12					3	12		3	15
1988	5					1	5		1	6
1989	9					1	9		1	10
1990						1			1	1
1991	15						15			15
1992	28						28			28
1993	29	5	1				29	5	1	35
1994	57	4	1			1	57	4	2	63
1995	134	12	1		5	8	134	17	9	160
1996	56	6					56	6		62
1997	25				1		25	1		26
1998	21				1		21	1		22
1999	24				1		24	1		25
2000	27				1		27	1		28
2001 [1]	19						19			19

[1] Provisional.

3.14.15 Salmon in the Main Basin and the Gulf of Bothnia (Subdivisions 22–31)

State of stocks/exploitation: Parr densities in most rivers being monitored in the Gulf of Bothnia have been improving and contributed to good wild smolt runs in 2000 and 2001. The survival rate of smolt to adult was low in the late 1990s (Figure 3.14.15.1). The status of the wild stock as a whole, although unquestionably improved, remains uncertain because the survival of smolt to adult in 2000 and 2001 is unknown. Catches of salmon are given in Tables 3.14.15.1 and 3.14.15.2. Decreased catches in the 1990s are largely explained by reduced TACs and strong regulations in coastal fisheries. Decreases are also considered to result from reduced survival of released salmon in post-smolt phase.

The proportion of wild salmon in the catch has increased since 1998, which is consistent with higher smolt production. Salmon smolt production estimates in the Gulf of Bothnia and Baltic Main Basin are shown below (in millions):

Year	Wild[1]	Reared	Total
1987	0.43	5.55	5.98
1988	0.42	5.67	6.09
1989	0.43	5.23	5.66
1990	0.42	4.39	4.81
1991	0.43	4.09	4.52
1992	0.47	4.70	5.17
1993	0.51	5.37	5.88
1994	0.60	3.95	4.55
1995	0.30	4.49	4.79
1996	0.31	4.74	5.05
1997	0.35	5.20	5.55
1998	0.46	5.61	6.07
1999	0.56	5.51	6.07
2000	1.27	5.67	6.94
2001	1.34	5.46	6.80
2002[2]	1.21	5.61	6.82

[1]Data on wild smolt production since the early 1990s is to a large extent based on annual parr surveys and applied estimation models. Smolt production estimates based on counts only for rivers Tornionjoki and Simojoki (20–30% of total natural production). [2]Preliminary data.

Wild stocks: Today about 90% of the total natural salmon production of the Baltic Sea occurs in the Gulf of Bothnia (Subdivisions 30-31) where 13 rivers are carrying wild salmon populations. In the early 1990s, most populations in this area were depleted. The management measures taken, including the reduction in TAC and the national regulatory measures in coastal areas, coincided with the occurrence of a strong brood-year class in 1990 and increased parr densities in almost all of these rivers in 1996–2001. Improved parr densities gave high smolt runs in 2000-2001 (3–4 year old smolts) and are expected to give good smolt runs still in 2002. (Table 3.14.15.3). The recent high smolt runs are expected to give good spawning runs in 2002–2005, provided that harvest rates and other sources of mortality will not exceed the rates which have occurred in the last few years. Fish counts in the fish ladders in a couple of the Swedish rivers in the Gulf of Bothnia indicated a good spawning run in 2001. In a small number of rivers entering into the Gulf of Bothnia, populations are improving only slowly, often from returning numbers of spawners so low that the stocks were at risk of collapse.

In the Main Basin area, the status of populations is good in terms of parr densities. However, the status of individual rivers is generally uncertain due to incomplete monitoring.

The proportion of wild smolt in total production has increased, being about 20% in 2001. Harvest rate analysis suggests an increasing trend in wild post-smolt natural mortality during the last ten years (Figure 3.14.15.1).

Reared stocks: Most of the salmon smolt recruitment originates from the releases (80% in 2001). About 70% of the total releases are carried out in the Gulf of Bothnia. Harvest rate analysis and tagging results suggest that pre-fishery survival of reared smolts has declined since the early 1990s (Figures 3.14.15.1 and 3.14.15.2). Despite reduced survival, more salmon are returning to the release sites (Figure 3.14.15.7), likely as a result of reduced fishing pressure resulting from stringent management measures in the coastal and offshore areas.

Management objectives: The IBSFC objective is to increase the natural production of wild Baltic salmon to at least 50% of the natural production capacity of each river by 2010, while retaining the catch level as high as possible.

The management objective is linked to the potential production of each individual river. However, an expert analysis suggests that the smolt production capacity estimates have been underestimated in particular for the biggest salmon rivers (Figure 3.14.15.3). Also the smolt production capacity estimates contain significant uncertainty.

Precautionary Approach reference points: Provisional fishing mortality reference points are now proposed for the first time for the Baltic salmon. $\mathbf{F}_{MSY}$ was calculated for the wild Baltic salmon population using the outputs of a harvest rate model and was taken as $\mathbf{F}_{lim}$. The stock-recruit function assumed was a

Beverton-Holt type, parameterised in terms of steepness and unfished smolt abundance.

The value for steepness was obtained from a meta-analysis of eight North-Atlantic salmon stocks due to the lack of corresponding data from any of the Baltic stocks. This analysis produced a potential distribution of values for steepness applicable to Baltic stocks. M74 was incorporated into the model by adjusting the steepness parameter.

The provisional $\mathbf{F}_{MSY}$ obtained was subject to the constraint that the relative amount of fishing effort in the longline, driftnet, coastal, and river fisheries remained constant and was kept the same as the average of the values observed in 2000 and 2001. The total cumulative fishing mortality rate at MSY for 2SW fish was used as the reference value for $\mathbf{F}_{MSY}$. The provisional $\mathbf{F}_{pa}$ was computed based on $\mathbf{F}_{lim}$ and its estimated uncertainty (including an estimate of implementation uncertainty).

For these stocks, $\mathbf{F}_{lim}$ (=0.49, cumulative F on 2SW fish until entrance to the river) gives a smolt production of 72% of that maximum possible production, as estimated in an expert opinion analysis (Table 3.14.15.4.). In the long run, fishing at $\mathbf{F}_{pa}$ (=0.31) decreases the combined yield on wild and reared stocks by 12 % but increases the wild smolt production to 81 % of maximum. In the current situation, the fishing mortality of the mixed stock fishery is higher than the provisional $\mathbf{F}_{pa}$ (Figure 3.14.15.5). For the less resilient stocks, the simulations suggest that the maximum yield would be obtained by much lower fishing mortality and, with the provisional $\mathbf{F}_{pa}$, there is still a risk for less productive populations to remain in their current poor state.

Nevertheless, adopting $\mathbf{F}_{pa}$ would be an improvement upon the current situation and, accordingly, ICES suggests that this provisional $\mathbf{F}_{pa}$ value be adopted and applied to guide management actions in the near future. Providing advice in terms of a catch corresponding to a fishing mortality reference point such as $\mathbf{F}_{pa}$ is more consistent with the current management practice of controlling the fisheries through TAC (and fleet quotas).

Advice on management: ICES advises that the national and international measures in place in 1997-2001, with the TAC for 2003 of 410 000 salmon, be continued. ICES also advises that the objective of meeting the 50% smolt production be revisited in the context of the proposed $\mathbf{F}_{pa}$ reference point. That will require discussions between ICES and IBSFC, as well as interactions to explain the underlying models and revise or refine them if needed.

ICES further advises that the exploitation close to the river mouths and in rivers should be closely monitored and kept sufficiently low to allow the number of spawning fish to increase.

Relevant factors to be considered in management: Improvement in many of the Gulf of Bothnian wild salmon stocks since the mid-1990s is a consequence of the favourable coincidences in mortality factors (i.e. lower incidence of M74) associated with the salmon life cycle, together with the regulatory measures in the fisheries. The factors influencing the development of M74 are poorly understood. The M74 mortality has varied over the years (Table 3.14.15.5) and sudden unpredictable changes in the incidence of the disease may occur. The speed and direction of development in stock status will depend both on the fishing mortality and variations in natural mortality. Parr densities and smolt production in most rivers have improved; however, salmon stocks in some rivers have not shown improvement despite the measures in place in the fisheries (Figures 3.14.15.4 and 3.14.15.6).

Simulations showed that, to protect 95% of all stocks, including those with lower resilience, the reference fishing mortality would have to be much lower than the provisional $\mathbf{F}_{pa}$ proposed above. Such a reference point would give a greater likelihood of recovering and maintaining the weak stocks close to their $\mathbf{B}_{MSY}$ levels. However, this would require that all Baltic fisheries be restricted in order to maintain this very low fishing mortality rate. The consequence of this strategy would be that a large percentage of the yield from the more productive Baltic salmon stocks would be forgone in any mixed stock fisheries.

Mark-recapture studies indicated that, from releases of 1.7 million reared fish per year in Subdivisions 30-31, an additional 35 000-45 000 spawners are available for catching in Swedish rivers or close to the river mouths. Analysis indicated differences in levels and trends between different parts of the Gulf of Bothnia, therefore these figures can not be generalized to rivers in Finland. No data suggest the existence of a large non-exploited amount of salmon in rivers in the Main Basin. Regarding the possible utilisation of these fish, ICES is aware that current harvest advice would result in a certain amount of reared fish returning to their release site, and would not be harvested with current management measures. If river-specific measures could be developed to harvest such surplus without by-catch of wild salmon, such harvesting could proceed, and be incremental to the TAC without causing a conservation concern. However, any such harvesting programs should be reviewed by ICES prior to implementation, to ensure that they provide protection to wild stocks. The data presented here are in contrast with the popular belief of a large (half-a-million or more) non-exploited surplus of reared salmon in many rivers.

TAC is an effective tool to safeguard salmon in the Main Basin to allow them to begin their spawning run. However, to restrict fishing mortality in coastal fisheries directed at homing wild salmon, complementary technical measures are essential and should be maintained.

Non-reported catches and discards are estimated to be about 20% of the reported landings (in numbers), each being about of the same magnitude. About 70% of discards are caused by seal damages. Catch losses have continued to increase and the most serious damage occurs in the Subdivisions 29–31. These losses are not included in the TAC.

Catch forecast for 2003 and short-term projection for fishing mortality and escapement:

A catch forecast model was developed and allowed the exploration of various fishing scenarios under two options for wild smolt production (recruitment) and a constant release of reared smolt. These provided insight on relative changes in yield at sea and in coastal areas (but river catches are not included), as well as relative changes in escapement, when effort was reduced by 0%-50% per year until $\mathbf{F}_{pa}$ was reached. For instance, with a 20% annual reduction in effort starting in 2003, $\mathbf{F}_{pa}$ would be reached by 2007 and give an improvement in relative survival to the river of 46%. With increasing smolt numbers, the F and relative survival would be the same, but yield and escapement in numbers would be higher.

Basis: Constant releases of 4.7 million reared smolts; relative survival, escapement and yield (reared+wild) are relative to 2002; the harvest rate (F) is given as a cumulative rate for the 2SW salmon by the entrance to the river, $\mathbf{F}_{lim}$=0.49, $\mathbf{F}_{pa}$=0.31**:**

Constant wild smolt production in 1996-2007 (0.3 million smolts – as seen in 1995 and 1996 when production was poor):

Change in effort	Yield (2003)	F(2007)	Relative survival to the river (2007)	Escapement in numbers (2007)	Yield (2007)
constant effort	1.00	0.63	0.99	0.99	1.00
10% annual decrease	0.92	0.45	1.24	1.24	0.69
20% annual decrease	**0.83**	**0.31**	**1.46**	**1.46**	**0.43**

With a 10% annual increase in wild smolt production in 1996-2007 (starting from 0.3 million smolts – believed to be more representative, but still below recent estimates):

Change in effort	Yield (2003)	F(2007)	Relative survival to the river (2007)	Escapement in numbers (2007)	Yield (2007)
Constant effort	1.09	0.63	0.99	1.59	1.60
10% annual decrease	1.00	0.45	1.24	2.00	1.09
20% annual decrease	**0.91**	**0.31**	**1.46**	**2.35**	**0.68**

Wild stocks: Based on parr densities in rivers, it is estimated that the natural smolt production will be 1.23 million smolts in 2002 (Table 3.14.15.3).

Reared stocks: The production of reared smolts is expected to be 5.61 million in 2002.

Medium- and long-term projections:
Not available.

Comparison with previous assessment and advice: There were no analytical assessments in previous years. In this assessment, a harvest model integrating the information on life history parameters and their uncertainties was developed to allow the evaluation of the response of the stock to a fishery closely matching the exploitation pattern in the Baltic salmon fishery. Production capacity was estimated from an expert opinion analysis using data from 13 rivers and these estimates, together with their uncertainties, were used to estimate the total production capacity for wild Baltic salmon stocks. This analysis, while preliminary, suggests that the total production capacity could be much higher than previously thought. A Monte-Carlo simulation was used to determine precautionary reference points ($\mathbf{F}_{lim}$, $\mathbf{F}_{pa}$) and to evaluate their relation to the new perception of the production capacity. A catch forecast model was also developed to evaluate the impact of various fishing scenarios in relative terms.

There is no change in the basis for the catch advice, but there is a need to engage in a discussion on the implications of the results from the new models on the objectives set in the current management plan.

Elaboration and special comment: To support management needs, the monitoring and assessment system of the Baltic salmon should enable the evaluation of the stock status and give answers to the management questions with an adequate precision and at reasonable costs. The balance between the costs and precision is not easy to achieve, and when applying the precautionary approach, higher uncertainty should lead to lower exploitation. In this sense, the specification of the needed precision in assessment is as much a management decision as a scientific decision.

In the current management approach, smolt production of wild stocks has been chosen as an operational objective. Behind this objective, there are more fundamental aims, e.g. to safeguard the genetic diversity of the wild and reared salmon stocks. In addition, catches are to be kept as high as possible. If the proposed $\mathbf{F}_{pa}$ was followed, these objectives could in part be met, but more conservative fishing mortality values would be needed to protect the weak stocks, so catches would not be kept as high as possible. These results are based on the current pattern of fishing mortality, which is mostly coastal and at sea.

At present, smolt production is estimated for several rivers from parr densities by regression models derived from the parr-to-smolt relationships in two rivers. The extrapolated estimates are uncertain, and there are no confidence limits available for these estimates. When monitoring the system, there will still be uncertainty caused by the unknown rate of post-smolt survival before these fish recruit to the fishery. In addition, as discussed earlier (Figure 3.14.15.3), the fulfilment of the objectives is very difficult to assess. For these reasons, IBSFC should consider setting alternative operational objectives (e.g. escapement, adherence to $\mathbf{F}_{pa}$, etc.).

ICES emphasises that several indicators (e.g. indicators of density and abundance at various stages of the life cycle from several rivers, indicators of fishing effort or fishing mortality) should be used when evaluating the state of the stocks and the data requirements for management actions. The current assessment procedure is flexible and can potentially utilise data from specific field studies, which could provide information that can be expanded to cover all populations. When assessing the state of the stocks, the following variables and criteria are probably the most important ones in the future:

1) Fishing mortality of wild stocks (to be close to $\mathbf{F}_{pa}$). This is assumed to be the rate of mortality where most of the stocks would have a good productivity with high probability and the total yield obtained would be close to maximum.

2) Parr density measurements from each wild salmon river would indicate the relative change in production (parr densities are observed after M74 mortality and have predictive power for the future state of stocks).

3) Stock composition of adult standing stock, with proportion of individual wild stocks. However, this is an estimate after the recruitment to the fisheries, and does not have very much predictive power due to the short life cycle of the salmon (short time between the data year and target year). When applying the new assessment methodology, these estimates can be obtained either by tagging of wild smolts or by genetic analysis.

These three variables cover different parts of the life cycle and would provide the information required for international management decisions. Fishing mortalities and parr densities can be measured by current monitoring, and they support the assessment system with reasonable accuracy. The monitoring of stock composition should be started and the required methodology should be developed.

In addition to these basic elements, there is a need to monitor other biological characteristics in order to get an overall view of the stock status. It is important that the local management needs and local interests be taken into account in field surveys. The information gained through monitoring must be understandable to all interested parties, from the local people (e.g. the owners of river fishing rights), to national management agencies and international commissions to get them committed to the objectives and make the management successful. Improvement in local surveys leads to better stock assessments across the whole Baltic Sea and allows a better appreciation of the impact of fishing.

Managers and ICES together should consider these aspects of monitoring and development of management strategies, and include them, if considered to be relevant, in the terms of reference for future assessment working group meetings.

Source of information: Report of the Baltic Salmon and Trout Assessment Working Group, 3 – 12 April 2002 (ICES CM 2002/ACFM:13).

Catch data (Tables 3.14.15.1–2):

TACs

Year	ICES Advice	Catch corresp. to advice '000 t	Rec TAC '000 fish	Agreed TAC[1] '000 t	Agreed TAC[1] '000 fish
1987	No increase in effort	-	-		
1988	Reduce effort	<3.00			
1989	TAC	2.90	850		
1990	TAC	1.68			
1991	Lower TAC	-[2]	-[2]	3.35	
1992	TAC		688	3.35	
1993	TAC		500[3]		650
1994	TAC		500[3]		600
1995	Catch as low as possible in offshore and coastal fisheries	-	-		500
1996	Catch as low as possible in offshore and coastal fisheries	-	-		450
1997	Catch as low as possible in offshore and coastal fisheries	-	-		410
1998	Offshore and coastal fisheries should be closed	-	-		410
1999	Same TAC and other management measures as in 1998		410		410
2000	Same TAC and other management measures as in 1999		410		450
2001	Same TAC and other management measures as in 2000		410		450
2002	Same TAC and other management measures as in 2001		410		450
2003	Same TAC and other management measures as in 2001		410		

Landings

Year	Rivers		Coast		Offshore		Coast and Offshore[4]		Total	
	'000 t	'000 fish	'000 t	'000 fish	'000 t	'000 fish	'000 t	'000 fish[5]	'000 t	'000 fish[5]
1987	0.05		0.39		3.21		3.59	891	3.64	897
1988	0.06		0.41		2.43		2.85	784	2.90	791
1989	0.08		0.65		3.27		3.92	1035	4.00	1049
1990	0.13		1.31		3.65		4.96	1113	5.08	1131
1991	0.12		1.03		3.00		4.03	757	4.15	776
1992	0.12		1.24		2.66		3.90	710	4.02	727
1993	0.11		0.83		2.57		3.40	679	3.52	657
1994	0.10		0.58		2.25		2.83	584	2.93	595
1995	0.12		0.67		1.98		2.65	553	2.77	571
1996	0.21	36	0.73	168	1.77	366	2.50	534	2.65	570
1997	0.28	45	0.78	149	1.53	282	2.31	431	2.59	476
1998	0.19	30	0.55	104	1.56	314	2.11	418	2.30	449
1999	0.17	30	0.57	104	1.25	256	1.82	360	1.99	390
2000	0.18	30	0.52	100	1.45	313	1.97	413	2.15	443
2001[6]	0.16	30	0.57	122	1.19	261	1.76	383	1.92	413

[1]TAC does not include river catch. [2]TAC much below present levels. [3]Equivalent to 2.25–2.70 thousand t.

[4]For comparison with TAC. [5]Catch in numbers before 1993 based on estimates. [6]Preliminary.

Table 3.14.15.1 Nominal catches of Baltic Salmon in tonnes round fresh weight, from sea, coast and river by country and region in 1972 - 2001. (2001 provisional figures). S=sea, C=coast, R=river.

	Main Basin (Subdivisions 22-29)										
Year	Denmark	Finland	Germany	Poland	Sweden		USSR		Total		
	S	S+C	S	S	S	R	S	C+R	S	C+R	GT
1972	1034	122	117	13	277	0	0	107	1563	107	1670
1973	1107	190	107	17	407	3	0	122	1828	125	1953
1974	1224	282	52	20	403	3	21	155	2002	158	2160
1975	1112	211	67	10	352	3	43	194	1795	197	1992
1976	1372	181	58	7	332	2	84	123	2034	125	2159
1977	951	134	77	6	317	3	68	96	1553	99	1652
1978	810	191	22	4	252	2	90	48	1369	50	1419
1979	854	199	31	4	264	1	167	29	1519	30	1549
1980	886	305	40	22	325	1	303	16	1881	17	1898

	Main Basin (Subdivisions 22-29)																							
Year	Denmark		Estonia		Finland			Germany	Latvia		Lithuania		Poland			Russia	Sweden				Total			
	S	C	S	C	S	C	R	S	S	C	S	C	S	C	R	S		S	C	R	S	C	R	GT
1981	844	*	23	0	310	18	0	43	167	17	36	na	45	na	na	56		401	0	1	1925	35	1	1961
1982	604	*	45	0	184	16	0	20	143	31	30	na	38	na	na	57		376	0	1	1497	47	1	1545
1983	697	*	55	0	134	18	0	25	181	105	33	na	76	na	na	93		370	0	2	1664	123	2	1789
1984	1145	*	92	0	208	29	0	32	275	89	43	na	72	na	na	81		549	0	4	2497	118	4	2619
1985	1345	*	87	0	280	26	0	30	234	90	41	na	162	na	na	64		842	0	5	3085	116	5	3206
1986	848	*	52	0	306	38	0	41	279	130	57	na	137	na	na	46		764	0	4	2530	168	4	2702
1987	955	*	82	0	446	40	0	26	327	68	62	na	267	na	na	81		887	0	4	3133	108	4	3245
1988	778	*	60	0	305	30	0	41	250	96	48	na	93	na	na	74		710	0	6	2359	126	6	2491
1989	850	*	67	0	365	35	0	52	392	131	70	na	80	na	na	104		1053	0	4	3033	166	4	3203
1990	729	*	68	0	467	46	1	36	419	188	66	na	195	na	na	109		949	0	9	3038	234	10	3282
1991	625	*	64	0	478	35	1	28	361	120	62	na	77	na	na	86		641	0	14	2422	155	15	2592
1992	645	*	19	4	354	25	1	27	204	74	20	na	170	na	na	37		694	0	7	2170	103	8	2281
1993	575	*	23	4	425	76	1	31	204	52	15	na	191	na	na	49		754	7	5	2283	139	6	2428
1994	737	*	2	4	372	80	1	10	97	33	5	na	184	na	na	29		574	11	8	2010	128	9	2147
1995	556	*	4	3	613	86	1	19	100	39	2	na	121	12	na	36		464	13	6	1915	153	7	2075
1996	525	*	2	4	306	53	1	12	97	53	14	na	124	1	na	35		551	8	5	1666	119	6	1791
1997	489	*	1	5	359	44	0	38	106	64	1	4	110	0	0	23		354	9	7	1481	126	7	1614
1998	485	10	0	4	324	14	0	42	65	60	1	4	105	9	4	33		442	3	7	1497	104	11	1612
1999	385	10	0	4	234	108	0	29	107	59	1	5	122	9	4	22		334	2	7	1234	197	11	1442
2000	411	10	1	7	282	87	0	44	91	58	0	5	125	13	6	23		461	2	8	1438	182	14	1634
2001	433	10	0	4	135	76	0	39	66	71	1	4	162	12	6	33		313	2	7	1181	178	13	1373
Mean 96-00	459	10	1	5	301	61	0	33	93	59	3	4	117	6	4	27	#DIV/0!	428	5	7	1463	146	10	1619

Table 3.14.15.1 (Cont'd)

Year	Gulf of Bothnia (Subdivisions 30-31)											Main Basin+Gulf of Bothnia (Subdivs. 22-31) Total		
	Denmark	Finland			Sweden			Total						
	S	S	S+C	C	S	C	R	S	C	R	GT	S	C+R	GT
1972	11	0	143	0	9	126	65	163	126	65	354	1726	298	2024
1973	12	0	191	0	13	166	134	216	166	134	516	2044	425	2469
1974	0	0	310	0	15	180	155	325	180	155	660	2327	493	2820
1975	98	0	412	0	33	272	127	543	272	127	942	2338	596	2934
1976	38	271	0	155	22	229	80	331	384	80	795	2365	589	2954
1977	60	348	0	142	49	240	60	457	382	60	899	2010	541	2551
1978	0	127	0	145	18	212	40	145	357	40	542	1514	447	1961
1979	0	172	0	121	20	171	35	192	292	35	519	1711	357	2068
1980	0	162	0	148	23	172	35	185	320	35	540	2066	372	2438

Year	Gulf of Bothnia (Subdivisions 30-31)										Main Basin + Gulf of Bothnia (Subdivisions 22-31) Total			
	Finland			Sweden			Total							
	S	C	R	S	C	R	S	C	R	GT	S	C	R	GT
1981	125	157	6	26	242	35	151	399	41	591	2076	434	42	2552
1982	131	111	3	0	135	30	131	246	33	410	1628	293	34	1955
1983	176	118	4	0	140	32	176	258	36	470	1840	381	38	2259
1984	401	178	5	0	140	52	401	318	57	776	2898	436	61	3395
1985	247	151	4	0	114	38	247	265	42	554	3332	381	47	3760
1986	124	176	5	11	146	41	135	322	46	503	2665	490	50	3205
1987	66	173	6	8	106	38	74	279	44	397	3207	387	48	3642
1988	74	146	6	1	141	48	75	287	54	416	2434	413	60	2907
1989	225	207	6	10	281	68	235	488	74	797	3268	654	78	4000
1990	597	680	14	12	395	103	609	1075	117	1801	3647	1309	127	5083
1991	580	523	14	1	350	90	581	873	104	1558	3003	1028	119	4150
1992	487	746	14	7	386	95	494	1132	109	1735	2664	1235	117	4016
1993	279	426	16	10	267	91	289	693	107	1089	2572	832	113	3517
1994	238	269	14	0	185	73	238	454	87	779	2248	582	96	2926
1995	66	302	20	0	214	97	66	516	117	699	1981	669	124	2774
1996	96	350	93	5	261	110	101	611	203	915	1767	730	209	2706
1997	44	360	110	1	295	158	45	655	268	968	1526	781	275	2582
1998	57	225	43	2	224	137	59	449	180	688	1556	553	191	2300
1999	17	175	23	1	195	133	18	370	156	544	1252	567	167	1986
2000	11	170	30	0	167	133	11	337	163	511	1450	519	177	2146
2001	9	218	26	1	175	117	10	393	143	546	1191	571	157	1919
Mean 96-00	45	256	60	2	228	134	47	484	194	725	1510	630	204	2344

Table 3.14.15.1 (Cont'd)

Year	Gulf of Finland (Sub-division 32)					Sub-division 22-32		
	Finland			USSR		Total		
	S	S+C	C	S	C+R	S	C+R	GT
1972	0	138	0	0	0	1864	298	2162
1973	0	135	0	0	0	2179	425	2604
1974	0	111	0	0	0	2438	493	2931
1975	0	74	0	0	0	2412	596	3008
1976	81	0	0	0	14	2446	603	3049
1977	75	0	0	0	13	2085	554	2639
1978	68	0	1	0	6	1582	454	2036
1979	63	0	3	0	4	1774	364	2138
1980	51	0	2	0	7	2117	381	2498

Year	Gulf of Finland (Sub-division 32)												Sub-division 22-32			
	Estonia			Finland			Russia		Total				Total			
	S	C	R	S	C	R	C	R	S	C	R	GT	S	C	R	GT
1981	0	2	0	46	1	0	5	0	51	3	0	54	2127	437	42	2606
1982	0	5	0	91	7	0	0	0	91	12	0	103	1719	305	34	2058
1983	0	3	0	163	32	0	0	0	163	35	0	198	2003	416	38	2457
1984	0	5	0	210	42	0	7	0	217	47	0	264	3115	483	61	3659
1985	0	4	0	219	34	2	20	0	239	38	2	279	3571	419	49	4039
1986	24	0	0	270	79	2	28	0	322	79	2	403	2987	569	52	3608
1987	10	0	0	257	61	2	23	0	290	61	2	353	3497	448	50	3995
1988	19	0	0	122	112	2	15	0	156	112	2	270	2590	525	62	3177
1989	36	0	0	181	145	2	37	0	254	145	2	401	3522	799	80	4401
1990	25	0	0	118	369	2	35	4	178	369	6	553	3825	1678	133	5636
1991	22	0	0	140	398	2	88	3	250	398	5	653	3253	1426	124	4803
1992	6	3	0	77	415	2	28	1	111	418	3	532	2775	1653	120	4548
1993 1)	3	1	1	91	309	3	39	2	133	310	6	449	2705	1142	119	3966
1994	3	1	0	88	141	6	15	1	106	142	7	255	2354	724	103	3181
1995	1	1	0	32	200	5	25	2	58	201	7	266	2039	870	131	3040
1996	0	3	0	83	324	10	10	2	93	327	12	432	1860	1057	221	3138
1997	0	4	0	89	341	10	4	0	93	345	10	448	1619	1126	285	3030
1998	0	4	0	21	156	10	0	3	21	160	13	194	1577	713	204	2494
1999	0	10	0	29	127	7	0	3	29	137	10	176	1281	704	177	2162
2000	0	14	1	37	130	11	0	4	37	144	16	196	1486	663	193	2342
2001	0	10	2	19	111	11	0	3	20	121	16	157	1211	693	173	2076
Mean 96-00	0	7	0	52	216	10	3	2	55	223	12	289	1565	853	216	2633

* No fishery occurred.

All data from 1972-1994, includes subdivisions 24-32, while it is more uncertain in which years subdivisions 22-23 are included. The catches in subdivisions 22-32 are normally less than one tonnes. From 1995 data includes

Catches from the recreational fishery are included as follows: Finland from 1980, Sweden from 1988, Denmark from 1998.

Other countries have no, or very low recreational catches.

Danish, Finnish, German, Polish and Swedish catches are converted from gutted to round fresh weight w by multiplying by 1.1.

Estonian, Latvian, Lithuanian and Russian catches before 1981 are summarized as USSR catches.

Estonian, Latvian, Lithuanian and Russian catches are reported as whole fresh weight.

Sea trout are included in the sea catches in the order of 3 % for Denmark (before 1983), 3% for Estonia, Germany, Latvia, Lithuania, Russia, and about 5% for Poland (before 1997).

Estonian sea catches in Subdivision 32 in 1986-1991 include a small quantity of coastal catches.

Estimated non-reported coastal catches in Subdivision 25 has from 1993 been included in the Swedish statistics.

Danish coast catches are non-profesional trolling catches.

1) In 1993 fishermen from the Faroe Islands caught 16 tonnes, which are included in total Danish catches.

Table 3.14.15.2 Nominal catches of Baltic Salmon in numbers, from sea, coast and river by country and region in 1996-2001 (2001 provisional figures). S=sea, C=coast, R=river.

Year	Main Basin (Subdivisions 22-29)															
	Denmark		Estonia		Finland			Germany	Latvia		Lithuania		Poland			Russia
	S	C	S	C	S	C	R	S	S	C	S	C	S	C	R	S
1996	105934	0	263	528	58844	8337	200	2400	19400	10577	1485	1059	27479	222	0	5199
1997	87746	0	205	1023	61469	7018	0	6840	20033	12095	214	665	24436	0	65	4098
1998	90687	2000	0	770	60248	2368	0	8379	13605	8098	288	781	23305	1927	890	6522
1999	73956	2000	28	741	45652	15007	0	5805	24309	9059	166	1132	24435	1835	860	4330
2000	82938	2000	129	1190	56141	12747	0	8810	24735	9106	78	1382	25051	2679	1195	4648
2001	88388	2000	122	819	26617	10706	0	7717	18194	10808	152	1053	32305	2471	825	6584

Year	Gulf of Bothnia (Subdivisions 30-31)										Main Basin + Gulf of Bothnia (Subdivisions 22-31) Total			
	Finland			Sweden			Total							
	S	C	R	S	C	R	S	C	R	GT	SEA	COAST	RIVER	GT
1996	22196	84940	14000	1181	61239	20571	23377	146179	34571	204127	366012	168224	35404	569640
1997	8205	76683	17000	251	49724	27159	8456	126407	44159	179022	282048	148623	45034	475705
1998	11105	46269	5100	329	41487	23438	11434	87756	28538	127728	313875	104273	30368	448516
1999	3529	35348	3100	89	38447	25546	3618	73795	28646	106059	256491	103977	30382	390850
2000	2423	37755	4150	13	32588	23291	2436	70343	27441	100220	312685	99847	29641	442173
2001	1904	49497	3750	122	44077	25022	2026	93574	28772	124372	260978	121838	30487	413303

Year	Gulf of Finland (Subdivision 32)												Subdivisions 22-32 Total			
	Estonia			Finland			Russia		Total							
	S	C	R	S	C	R	C 1)	R	S	C	R	GT	SEA	COAST	RIVER	GT
1996	0	396	0	20664	55840	1500	1485	296	20664	57721	1796	80181	386676	225945	37200	649821
1997	0	819	0	19577	54493	1500	1023	0	19577	56335	1500	77412	301625	204958	46534	553117
1998	22	761	76	4210	23876	1500	65	650	4232	24702	2226	31160	318107	128975	32594	479676
1999	12	1904	132	6234	19306	1100	95	915	6246	21305	2147	29698	262737	125282	32529	420548
2000	79	2833	254	8105	21040	1900	79	835	8184	23952	2989	35125	320869	123799	32630	477298
2001	62	1965	317	3804	17578	1900	82	726	3866	19625	2943	26434	264844	141463	33430	439737

Data from the recreational fishery are included in Swedish and Finnish data. Recreational fishery are included in Danish data from 1998. Other countries have no, or very low recreational catches.
In 1996 sea trout are included in the Polish catches in the order of 5%.
1) Russian coastal catches have in earlier reports been recorded as sea catches.

Region, Sub-div. country and river	Category	Reprod. area ha	1993	1994	1995	1996	1997	1998	1999	2000	2001	Pred 2002	Pred 2003	Method of estimate Pot.prod.	Pres.prod.	Reared 2001
Gulf of Bothnia, Sub-div. 31																
Finland																
Kiiminkijoki	potential	90	+	+	+	+	+	+	1	0.1	0.1	+	0.1	3	4	65
Pyhäjoki	potential	100	+	+	+	+	+	+	+	0.1	0.1	+	0.1	3	4	150
Simojoki	wild	255	10	12	1.4	1.3	2.5	9.4	9	57.4	47.3	47.2	43.5	3	2	55
Finland/Sweden																
Tornionjoki;Torne älv	wild	5000	123	199	75	71	50	144	175	500	620	594	370	3	2	40
Sweden																
Kalix älv	wild	2500	88	130	42	48	61	55	83.7	236	287	212	218	3	4	
Råne älv	wild	390	+	3.2	2.1	2.2	0.5	1	2	8.1	8.8	7.1	3.5	3	4	
Pite älv	wild	435	+	+	3	3	5	5.6	4.2	5.1	18	11.6	6.8	3	5	
Åby älv	wild	80	+	5.8	1.9	2.3	3	6	6.5	9.9	16.3	18.2	9.9	3	4	
Byske älv	wild	530	23	35	11	12	40	33	49	140	106	117	87.5	3	4	
Sävarån	wild	20	+	+	0.5	0.2	0.4	0.7	0.7	1.1	1.5	1.5		3	4	
Rickleån	wild	15	+	+	0.3	0.1	0.3	0.3	0.4	0.2	0.9	1		3	1 and 3	
Ume/Vindelälven	wild	1000	23	39	15	14	13	24	52	116	75	36.5	44.3	3	4	
Öre älv	wild	100	+	1.4	1.4	1.4	0.1	0.7	0.4	0.5	0.9	0.9		3	4	
Lögde älv	wild	95	+	3.8	1.4	1.7	1.1	3.5	4.6	0.6	4.1	5.9		3	4	
Sum of +			20	4	4	4										
Total Sub-div. 31		**10610**	**287**	**433**	**159**	**161**	**177**	**283**	**389**	**1075**	**1186**	**1053**	**784**			**310**
Gulf of Bothnia, Sub-div. 30																
Ljungan	mixed	20	15	4	4	4	5	10	10	10	10	10	10	3	4	
Total Gulf of B., Sub-divs.30-31			**302**	**437**	**163**	**165**	**182**	**293**	**399**	**1085**	**1196**	**1063**	**794**			**310**
Main Basin, Sub-divs. 22-29																
Sweden																
Emån	wild	21.7	5	4.5	3	2.5	4	3.5	4	5	3	3		3	4	
Mörrumsån	wild	44	90	60	30	35	60	60	76	98	70	67.7		3	4	
Total Sweden			95	64.5	33	37.5	64	63.5	80	103	73	70.7	0	6	8	
Estonia																
Pärnu	wild	3					3	2	1	0.1	0.1	0.1	0.1	4	3 and 4	
Latvia (1)																
Salaca	wild		22	15	15	20	20	29	27	19	29	29	25	3	2	
Vitrupe	wild		5	5	5	5	5	4	4	4	2	2	2	6	5	
Peterupe	wild		5	5	5	5	5	4	4	4	2	2	2	6	2 and 5	
Gauja	mixed		17	13	13	14	14	13	13	13	12	15	15	6	2 and 5	277
Daugava	mixed		5	5	5	5	5	5	5	5	2	5	5	6	5 and 7	643
Irbe	wild		10	10	8	7	7	7	7	7	5	5	5	6	5	
Venta	mixed		15	15	15	15	12	12	12	12	10	12	12	6	2 and 5	85
Saka	wild		10	10	10	10	8	7	7	7	2	7	5	6	5	
Uzava	wild		2	2	2	2	2	1	2	2	2	1	2	6	5	
Barta	wild		2	2	2	2	2	1	1	1	2	1	2	6	5	
Total Latvia			93	82	80	85	80	83	82	74	68	79	75			1004

Table 3.14.15.3 (Cont'd)

Lithuania																
Nemunas river basin	wild		20	20	20	20	20	20	2.2	5	4.2	n/a		7	10	
Total Main B., Sub-divs. 22-29			**208**	**167**	**133**	**143**	**167**	**169**	**165**	**182**	**145**	**149.8**	**75.1**			**1004**
Gulf of B.+Main B., Sub-divs. 22-31			**510**	**604**	**296**	**308**	**349**	**462**	**564**	**1267**	**1341**	**1213**	**869**			**1314**
Gulf of Finland, Sub-div. 32																
Finland																
Kymijoki	mixed	50			3	3	4	4	4	4	4	4	4	3	4	
Total Finland		60			3	3	4	4	4	4	4	4	4	3	4	0
Russia																
Neva	mixed	20			7	7	7	7	7	7	6	7		7	6 and 8	
Luga	mixed	40			4	4	4	4	4	5	2.5	5		7	6 and 8	
Total Russia		60			11	11	11	11	11	12	8	12				0
Estonia																
Kunda	wild	1.5	+	+	+	+	+	+	+	1.8	0.8	0.4	2.1	3	3 and 4	
Selja	mixed	9	+	+	+	+	+	0	0	1.4	0.2	0.11	0.2	3	3 and 4	
Loobu	wild	6	+	+	+	+	+	+	0	0.3	0.3	0.4	0	3	3 and 4	
Pirita	mixed	10	+	+	+	+	+	0	0	0	0.6	0	0.2	3	3 and 4	
Vasalemma	wild	1	+	+	+	+	+	+	+	0	0.1	0.1	0.1	3	3 and 4	
Keila	wild	3.5	+	+	+	+	+	+	+	0.3	1.5	0.2	0	3	3 and 4	
Valgejögi	mixed	1.5	0	0	0	0	0	0	0	0	0.1	0.1	0.2	3	3 and 4	
Jägala	mixed	0.3	0	0	0	0	0	0	0	0	0	0	0.2	3	3 and 4	
Vääna	mixed	3.5	0	0	0	0	0	0	0	0	0	0.004	0	3	3 and 4	
Total Estonia		36.3	15	15	7	7	8	6	2	3.8	3.6	1.314	3			
Total Gulf of F., Sub-div. 32		**156.3**	**15**	**15**	**21**	**21**	**23**	**21**	**17**	**20**	**16**	**17**	**7**			**0**
Total Baltic, Sub-divs. 22-32 (1)			**525**	**619**	**317**	**329**	**372**	**483**	**581**	**1287**	**1357**	**1230**	**876**			**1314**

+ = Low and uncertain production. (1) Estimate of potential production in Latvia is missing. n/a No data available.

Methods of estimating production

Potential production

1. Stock-recruitment curve.
2. Estimate of reproduction area, quality gradation of them and estimate of peak production per area from other source.
3. Estimate of reproduction area and peak production per area from other sources.
4. Accessible linear stream length and peak production per area from other sources.
5. Salmon catch series, exploitation and survival estimates.
6. No data.

Present production

1. Complete count of smolts.
2. Sampling of smolts and estimate of total smolt run size.
3. Estimate of smolt run from parr production by relation developed in the same river.
4. Estimate of smolt run from parr production by relation developed in another river.
5. Inference of smolt production from data derived from similar rivers in the region.
6. Count of spawners.
7. Estimate inferred from stocking of reared fish in the river.
8. Salmon catch, exploitation and survival estimate.
9. No data.
10. Not known.

Table 3.14.15.4 Effect of following of reference points on the yield and smolt production of wild salmon population in the long run.
The F(lim) is based on median of F (msy) and mean M74 variability. F (msy) is calculated by keeping the same relative efforts in various fisheries.
The fishing mortality for each age is cumulative until the given age (all fishing before spawning, selectivity effects included).
Relative smolt production is given in respect to maximum.

F(lim) using median value of steepness and mean trend of M74							
Age	F(msy) = F (lim)	Relative Yield	Relative smolt prod	Age	F(pa)	Relative Yield	Relative smolt prod
1SW	0.2	100%	72%	1SW	0.126181	88%	81%
2SW	0.49			2SW	0.309143		
3SW	0.77			3SW	0.485797		
4SW	1			4SW	0.630905		
5SW	1.31			5SW	0.826486		

Table 3.14.15.5. M74-mortality (in %) of searun female spawners belonging to reared populations of Baltic salmon in hatching years 1985-2000 with projections for year 2001. All data originate from hatcheries.

River	Subdiv.	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Simojoki (2)	31		6	2	6	3	*12*	0	53	74	*53*	92	*86*	91	31	59	38	42	
Torne älv (2)	31				5	6	1	29	70	76	89	76			25	61	32	30	
Lule älv	31								58	66	62	50	52	38	6	34	21	29	37
Skellefteälven	31								40	49	69	49	77	16	5	42	12	14	
Ume/Vindelälven	30	40	20	25	19	16	31	45	77	88	90	69	78	37	16	53	45	39	
Ångermanälven	30								50	77	66	46	63	21	4	28	21	25	
Indalsälven	30	4	7	8	7	3	8	7	45	72	68	41	64	22	1	20	22	7	
Ljungan	30								64	*96*	*50*	56	28	*29*	10	25	10	0	
Ljusnan	30							17	33	75	64	56	72	22	9	41	25	46	
Dalälven	30	28	8	9	20	11	9	21	79	85	56	55	57	38	17	33	20	33	37
Mörrumsån	25	47	49	65	46	58	72	65	55	90	*80*	63	*56*	23					
Neva/Åland	29									70	50								
Neva/Kymi	32								45	60-70		57	*40*	*79*	42	20	28		
Mean River Indalsälven, Dalälven		16.0	7.5	8.5	13.5	7.0	8.5	14.0	60.7	74.3	62.0	48.7	57.7	32.7	8.0	29.0	21.0	23.0	
Mean total		29.8	18.0	21.8	17.2	16.2	22.2	26.3	55.8	76.5	66.4	59.2	61.2	37.8	15.1	37.8	24.9	26.5	

1.) River Lule älv missing before 1992 and River Indalsälven in year 2000.

All estimates known to be based on material from less than 20 females in italics.

2.)The estimates in the rivers Simojoki and Tornionjoki/Torne älv are if possible given as the percentage of females affected by M74 and secondly, percentage of yolk-sac-fry mortality.

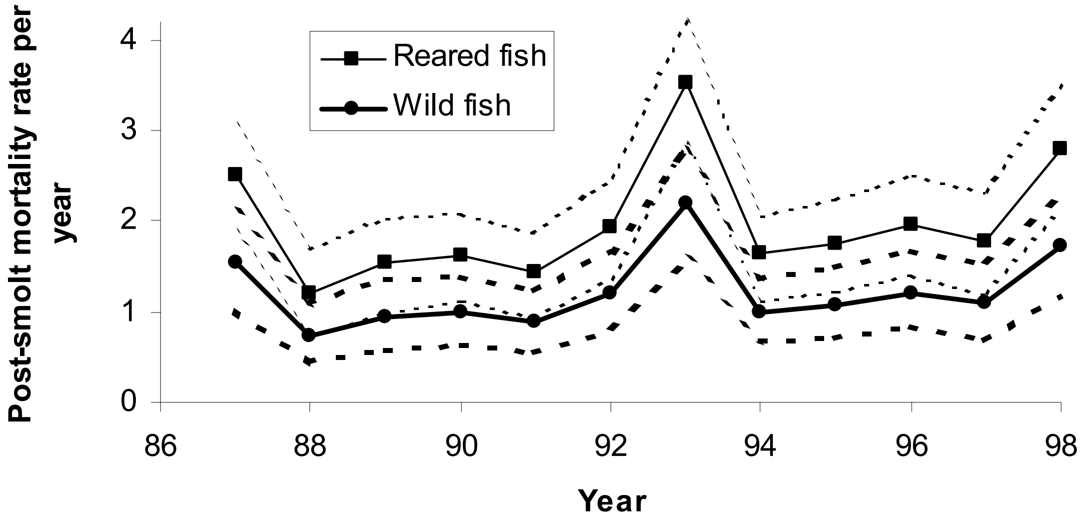


Figure 3.14.15.1. Post-smolt mortality rate per year for wild and hatchery-reared fish (median and 95% probability interval).

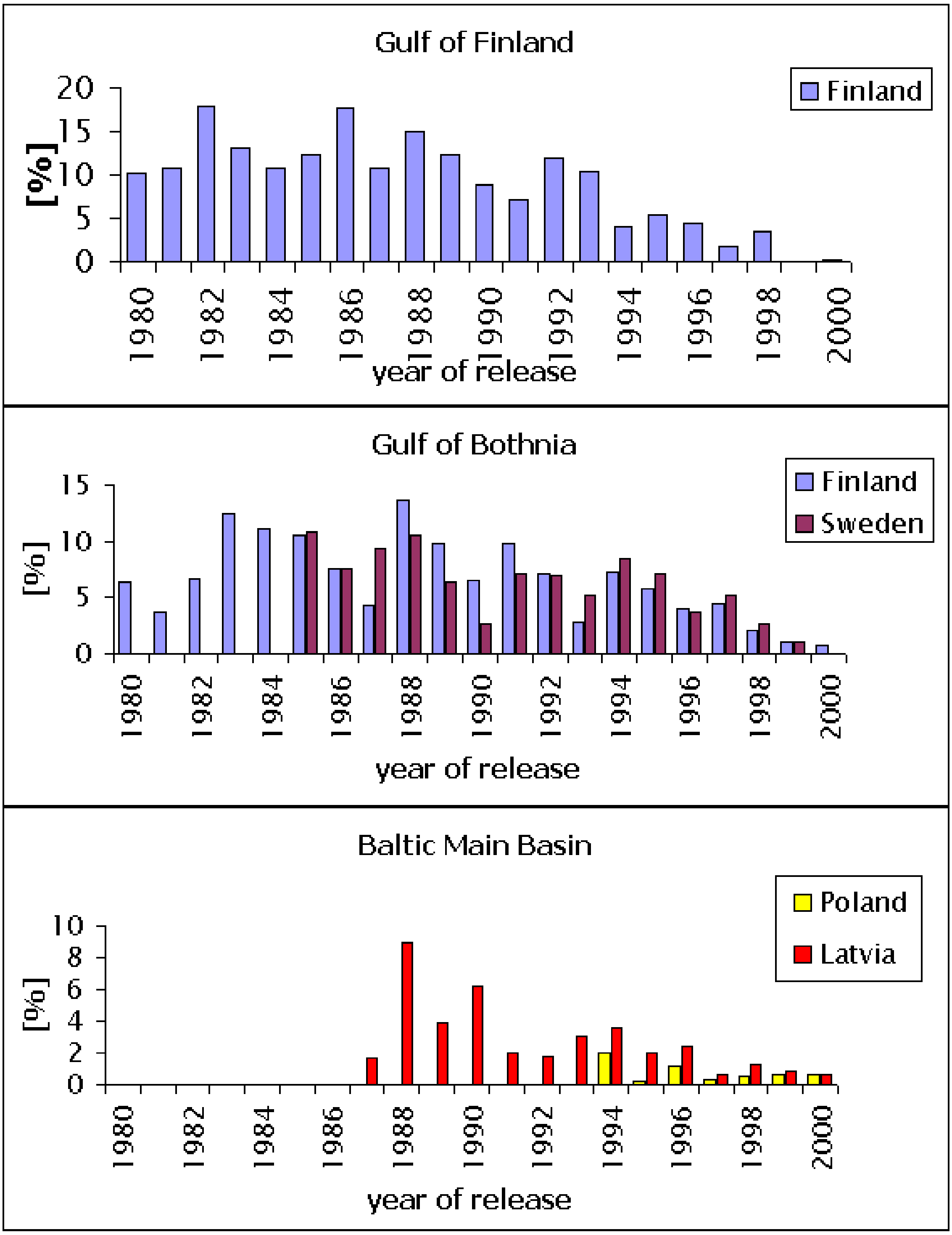


Figure 3.14.15.2 Recapture rate (in percent) of the tagged reared salmon smolts in Gulf of Finland, Gulf of Bothnia, and Baltic Main Basin.

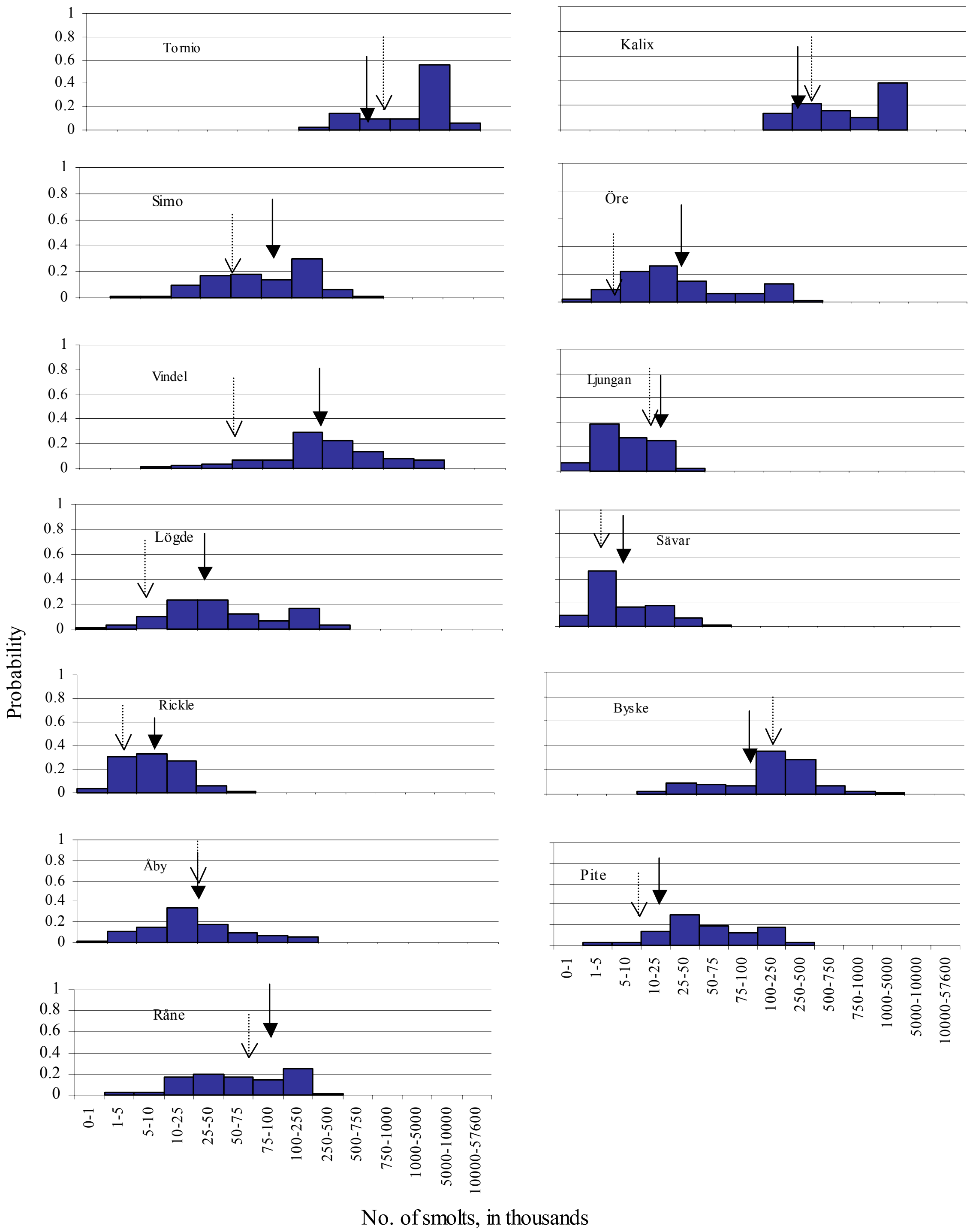


Figure 3.14.15.3. Probability distributions for smolt production capacities in the Gulf of Bothnia wild salmon rivers based on an expert analysis (Uusitalo *et al*, unpubl.). Numbers of smolts in thousands. Solid arrows indicate previously estimated production potential and dashed arrows indicate the predicted smolt production in 2001. Note that x-axis is not linear.

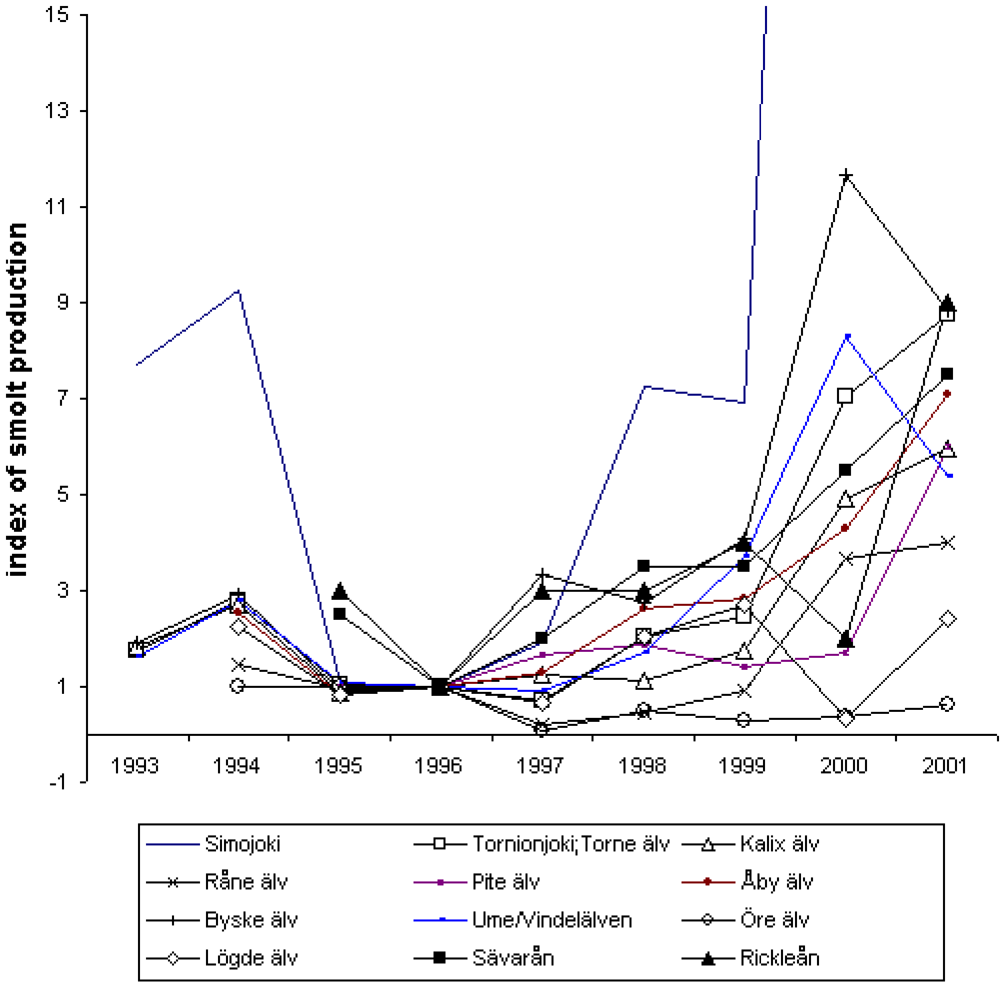


Figure 3.14.15.4. The development of smolt production in some Finnish and Swedish rivers expressed as an index. The different years have been compared to the year 1996, which was selected a starting point and was given a value of 1. In the river Simojoki the index reached the values of 44 and 36 in 2000 and 2001, respectively. Only in the rivers Simojoki and Tornionjoki the smolt production had been estimated by smolt trapping, in other rivers the smolt production estimates are based on parr densities and egg deposition calculations

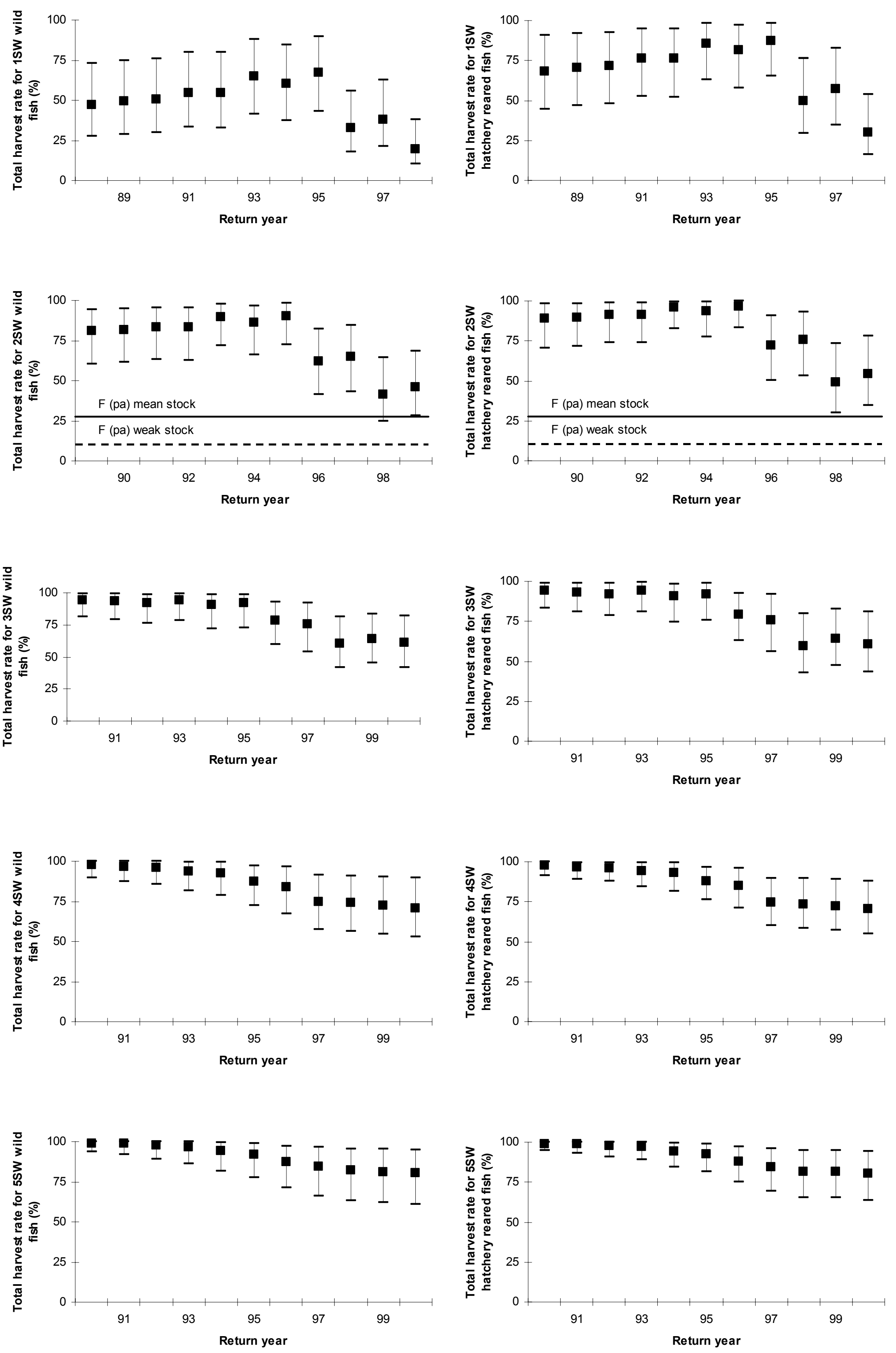


Figure 3.14.15.5. Median and 95% probability interval for the total harvest rate (cumulated by the given age) for wild and hatchery-reared salmon of the river Torne, the river Simo, the river Kemijoki and the river Iijoki, returning to the rivers between 1989 and 1999. The figures for 2SW fish indicate the level of provisional $\mathbf{F}_{pa}$ for the mean stock and $\mathbf{F}_{pa}$ for the weak stock.

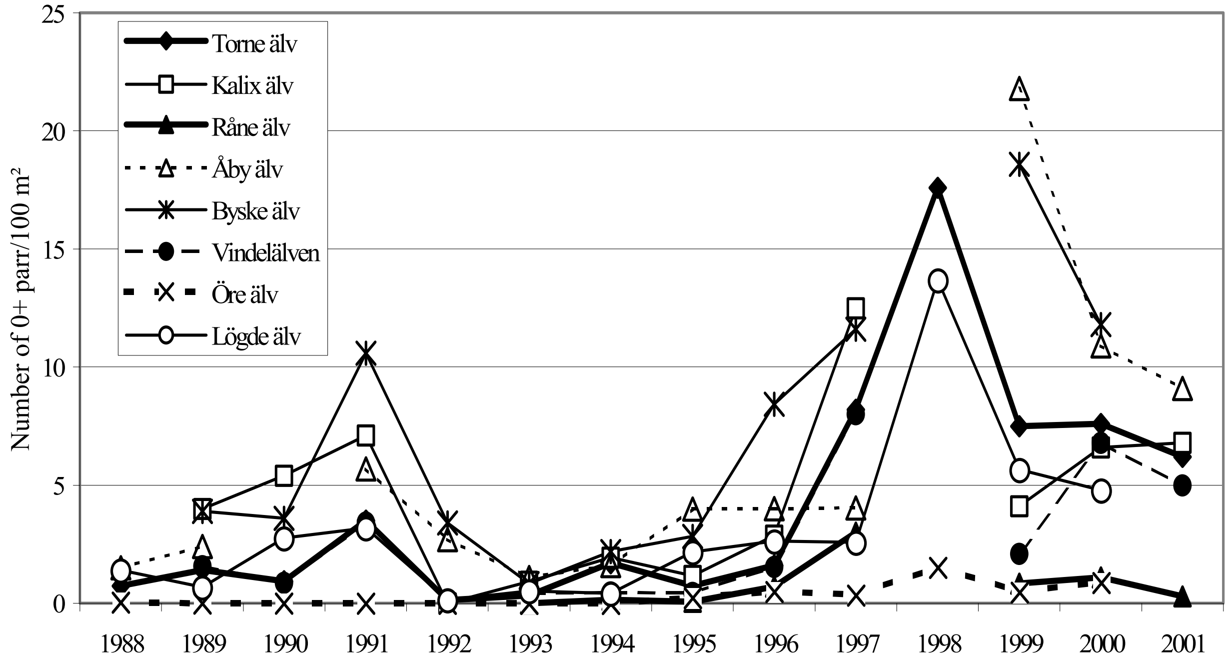


Figure 3.14.15.6 – Densities of 0+ parr in rivers in the Gulf of Bothnia (Subdivision 31) in 1998-2001.

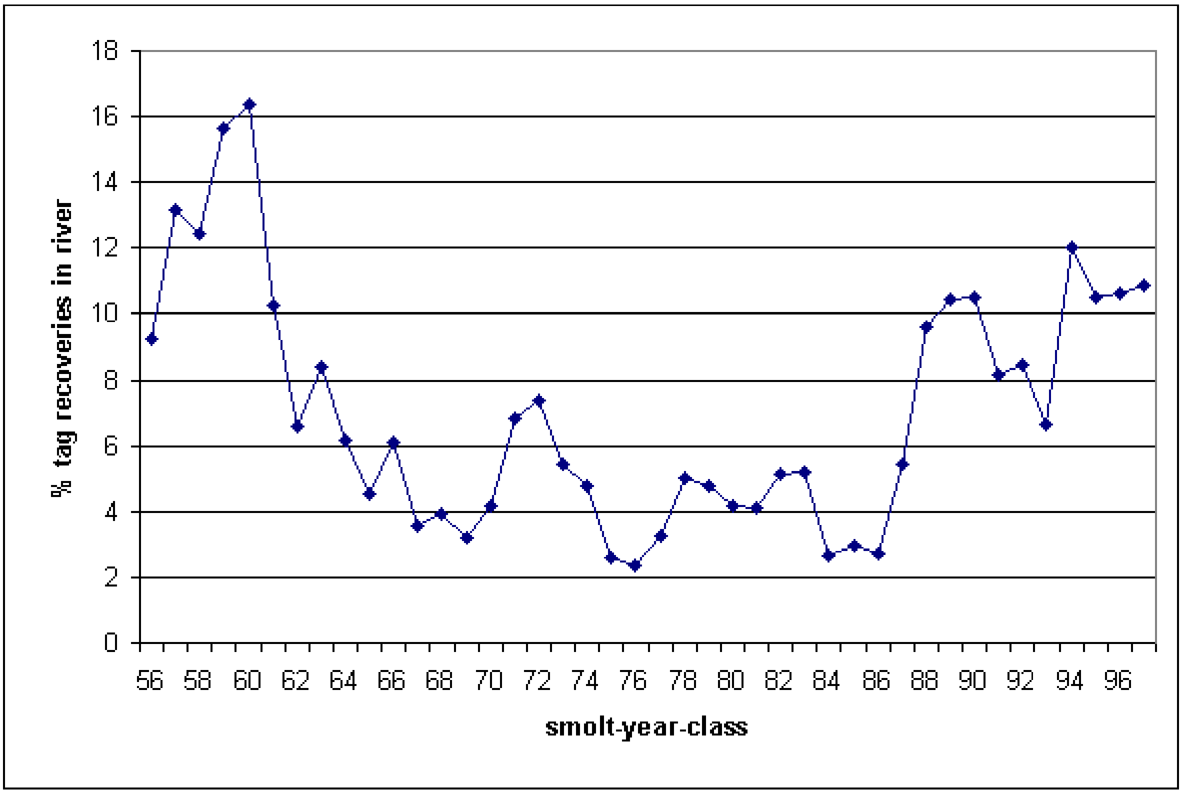


Figure 3.14.15.7 Percent of total tag recoveries in rivers from Swedish smolt releases in Gulf of Bothnia by year of release in years 1956-1997.

3.14.16 Salmon in the Gulf of Finland (Subdivision 32)

State of stocks/exploitation: ICES considers that the wild stocks are outside safe biological limits. Parr densities are very low in many rivers carrying wild salmon populations (Table 3.14.16.1). Catches of salmon in the area are low (Table 3.14.16.1-2).

Salmon smolt production in the Gulf of Finland is shown below (in thousands):

Year	Wild[1]	Reared	Total
1987	15	593	608
1988	15	569	584
1989	15	432	447
1990	15	573	588
1991	15	501	516
1992	15	415	430
1993	15	558	573
1994	15	633	648
1995	10[3]	710	720
1996	10[3]	661	671
1997	12[3]	690	702
1998	10[3]	722	732
1999	6[3]	891	897
2000	8[3]	826	834
2001	8[3]	1121	1129
2002[2]	5[3]	1064	1069

[1]Data on wild smolt production assumed until 1994. 1995 figures based on surveys. [2]Preliminary data. [3]Data on wild production in Russia reported for 1995–2000: 11 000 smolts annually. Not included in table.

Wild stocks: Based on earlier evidence there are wild salmon populations in 9 Estonian rivers in the Gulf of Finland. Surveys indicate that parr densities vary strongly in these rivers, and densities are much lower than in rivers of similar type at these latitudes in average (Table 3.14.16.1). Five of these populations have been supported by smolt releases in the last few years.

Minor natural reproduction occurs as a consequence of large long-term releases in one Finnish river in the area. Surveys also indicate that some natural reproduction occurs in one or two Russian rivers. Also these two populations are supported by long-term releases (Table 3.14.15.3). However, there are no national plans to attain self-sustainable populations in these rivers.

Reared stocks: Most of the salmon catch in the Gulf of Finland originates from smolt releases. Despite increases in releases, the catches have decreased considerably in the last few years, which indicate a lowered initial smolt survival of released salmon (Figure 3.14.16.1). Also tagging results give evidence for decreased survival of reared smolts (Figure 3.14.15.2).

Management objectives: The IBSFC objective is to increase the natural production of wild Baltic salmon to at least 50% of the natural production capacity of each river by 2010, while retaining the catch as high as possible.

Precautionary Approach reference points:
Not established.

Advice on management: ICES recommends that, in light of the precarious state of wild stocks in the Gulf of Finland and the very low wild smolt production in 2001, fisheries should only be permitted at sites where there is virtually no chance of taking wild salmon along with reared salmon. It is particularly urgent that national conservation programmes to protect wild salmon be enforced around the Gulf of Finland.

Relevant factors to be considered in management: At present wild salmon populations occur in nine Estonian rivers and many of these populations are at risk of extinction. The potential smolt production is very small compared to all other wild salmon populations in the Baltic Sea. It is uncertain whether a much reduced TAC would affect the status of these stocks. The TAC has been reduced 5 times since 1996 but, in 2001, it was still about 3 times the catch, and not restrictive on harvests. Coastal fisheries at sites likely to be on migration paths of wild salmon from Estonian rivers present a particular threat to the biological viability of these wild stocks. Coastal and river fisheries intercepting these populations should be prohibited. All possible means should be used to prevent all fishing in rivers and river mouths supporting these wild stocks. Additionally, enhancement releases should be continued and expanded to avoid possible extinction of these stocks.

M74 caused high mortality among offspring of sea-run females in Finnish hatcheries in 1992–1997, but the M74-related mortality has lowered since 1998. No estimates are available for the mortality in 2002 (Table 3.14.15.5). Hatchery experiments suggest that M74-related mortality is low in Estonian salmon populations.

Tagged Latvian salmon recovered in the Gulf of Finland suggest that reared Latvian salmon to some extent are also exploited in this area.

Catch forecast for 2003: A *status quo* projection for Subdivision 32 gives a catch prediction for 2002 and 2003 of 32 000 and 39 000 fish, respectively, to be compared to the catch in 2001 of 26 000 fish. The TAC for 2002 of 60 000 salmon is therefore not restrictive to the fishery.

Wild stocks: Based on parr densities, it is estimated that smolt production of Estonian rivers will be about 3000 salmon in 2002.

Reared stocks: The smolt production is expected to be about 1.06 million smolts in 2002.

Comparison with previous assessment and advice: No change in basis.

Elaboration and special comment: Considering that, at present, released smolts are estimated to outnumber wild smolts by approximately 200:1 in this area, the current management measures may be insufficient to ensure preservation of these stocks. Under these circumstances, it would be appropriate to adopt additional measures specifically intended to prevent the biological extinction of wild salmon in the Gulf of Finland.

Small reproduction areas and unpredictable variation in the size of year-classes is characteristic of Estonian wild salmon rivers. Electrofishing surveys since the 1970s indicate that there has been no spawning in some years. In spite of improvement in the water quality in the 1990s, the natural reproduction has not increased in these rivers.

Fishing effort off the Estonian coast increased significantly in the 1990s. This partly-illegal fishery developed quickly because the coastal fish stocks, salmonids included, had been under-exploited and catches were relatively good. The decline of agriculture and other industries in the region that resulted in decreased pollution of the streams should have had a positive effect on the salmon stocks. However, the decrease in the offshore fishery and improvement of water quality did not compensate for the effect of the increased coastal fishery, which exploits salmon and sea trout populations as by-catch.

The Finnish offshore and, especially, coastal fishery catch the major part of the total landings in the Gulf of Finland. However, the total effort has decreased in the last few years because of the low catch per unit of effort combined with low price and, in particular, increased seal damages. Damage caused by seals is most severe at fishing sites furthest away from the coast, which has caused the trapnet fishing to move closer to the shoreline.

There was no Russian commercial salmon fishery in the Gulf of Finland in year 2000, but the catch consisted of by-catch from other fisheries.

The assessment shows a very low initial survival for released smolts in the last four years compared to the early 1990s.

The assessment is based on catch -at-age estimated from tag recoveries and catch samples. Estimates of wild production are based on limited surveys and do not include all rivers. Lack of data on the productivity in the freshwater phase prevents calculation of the appropriate TAC strategy to meet any target based on smolt production.

Source of information: Report of the Baltic Salmon and Trout Assessment Working Group, 3 – 12 April 2002 (ICES CM 2002/ACFM:13).

Catch data (Table 3.14.16.1-2):
TACs

Year	ICES Advice	Catch corresp. to advice '000 fish	Agreed TAC '000 t	Agreed TAC '000 fish
1987	No advice	-		
1988	No advice	-		
1989	No advice			
1990	No advice			
1991	No advice		0.43	
1992	No advice		0.43	
1993	TAC for reared stock	109[1]		109
1994	TAC for reared stock	65[2]		120
1995	Catch as low as possible in offshore and coastal fisheries	-		120
1996	Catch as low as possible in offshore and coastal fisheries	-		120
1997	Offshore and coastal fisheries should be closed	-		110
1998	Offshore and coastal fisheries should be closed	-		110
1999	Offshore and coastal fisheries should be closed	-		100
2000	Only fishery on released salmon should be permitted	-		90
2001	Only fishery on released salmon should be permitted	-		70
2002	Only fishery on released salmon should be permitted	-		60
2003	Only fishery on released salmon should be permitted			

[1]Equivalent of 600 t. [2]Equivalent of 400 t.

Landings

Year	River	Coast	Offshore	Coastal and offshore[2]		Total	
	t	t	t	t	'000 fish	t	'000 fish
1987	2	61	290	351		353	
1988	2	112	156	268		270	
1989	2	145	254	399		401	
1990	6	369	178	347		553	
1991	5	398	250	648		653	
1992	3	418	111	529		532	
1993	6	310	133	443		449	111
1994	7	142	106	248		255	57
1995	7	201	58	259	38	266	39
1996	12	327	93	420	78	432	80
1997	10	345	93	438	76	448	77
1998	13	160	21	181	29	194	31
1999	10	137	29	166	28	176	30
2000	16	144	37	181	32	197	35
2001[1]	16	121	20	141	23	157	26

[1]Preliminary. Table revised because of additional data.
[2] For comparison with TAC.

Table 3.14.16.1. Densities of wild salmon parr in electrofishing surveys at permanent stations in rivers discharging into the Gulf of Finland, Subdivision 32.

River	Year	Number of parr/100m2		Number of parr
		0+	1+ and older	
Kunda				
	1992	7.4	12.9	118
	1993	0	4.5	26
	1994	2.4	0.0	7
	1995	15.4	3.1	60
	1996	22.6	13.7	98
	1997	1.2	21.5	78
	1998	13.8	0.9	68
	1999	6.4	18.1	103
	2000	20.8	7.6	75
	2001	30.3	14.7	156
Selja				
	1995	1.3	6.5	18
	1996	0.0	0.4	1
	1997	0.0	0.0	0
	1998	0.0	0.0	0
	1999	0.1	2.3	26
	2000	1.2	0.4	32
	2001	1.4	3.7	33
Loobu				
	1994	1.2	2.8	23
	1995	0.2	0.2	2
	1996	0.0	0.4	2
	1997	0.0	0.3	3
	1998	0.2	0.0	1
	1999	10.5	0.8	70
	2000	0.6	0.8	17
	2001	0.0	0.5	3
Valgejõgi				
	1998	0	0	0
	1999	2.4	0	26
	2000	0.4	1	14
	2001	4.4	1.6	58
Jägala				
	1998	0	0	0
	1999	0.5	0	2
	2000	0	0	0
	2001	16.2	0	38
Pirita				
	1992	1.9	0.7	11
	1993*)			
	1994	0	0	0
	1995	0	0	0
	1996	0	+	1
	1997*)			
	1998	0	0	0
	1999	6.5	0	55
	2000	0	0.9	13
	2001	1.2	0.3	18
Vääna				
	1998	0	0.1	1
	1999	0	0	0
	2000	0.1	0	1
	2001	0	0	0
Keila				
	1994	1.1	1.1	12

Table 3.14.16.1 (Cont'd)

	1995	6.9	0.3	105
	1996	11.7	1.1	115
	1997	0	5.2	47
	1998	0	1.1	10
	1999**)	95	1.3	154
	2000	3.8	6.6	52
	2001	0	2.2	21
Vasalemma				
	1992	3.4	2.6	23
	1993*)			
	1994	1.9	0	7
	1995	18.7	0.4	99
	1996	4.8	5	51
	1997	0	1.5	8
	1998	0	0.2	2
	1999	13.5	0	80
	2000	3.5	1.7	27
	2001	0.4	0.9	3

*) = no electrofishing
**)= Flow was extremely small and fish were concentrated on little area
+ = minor production.

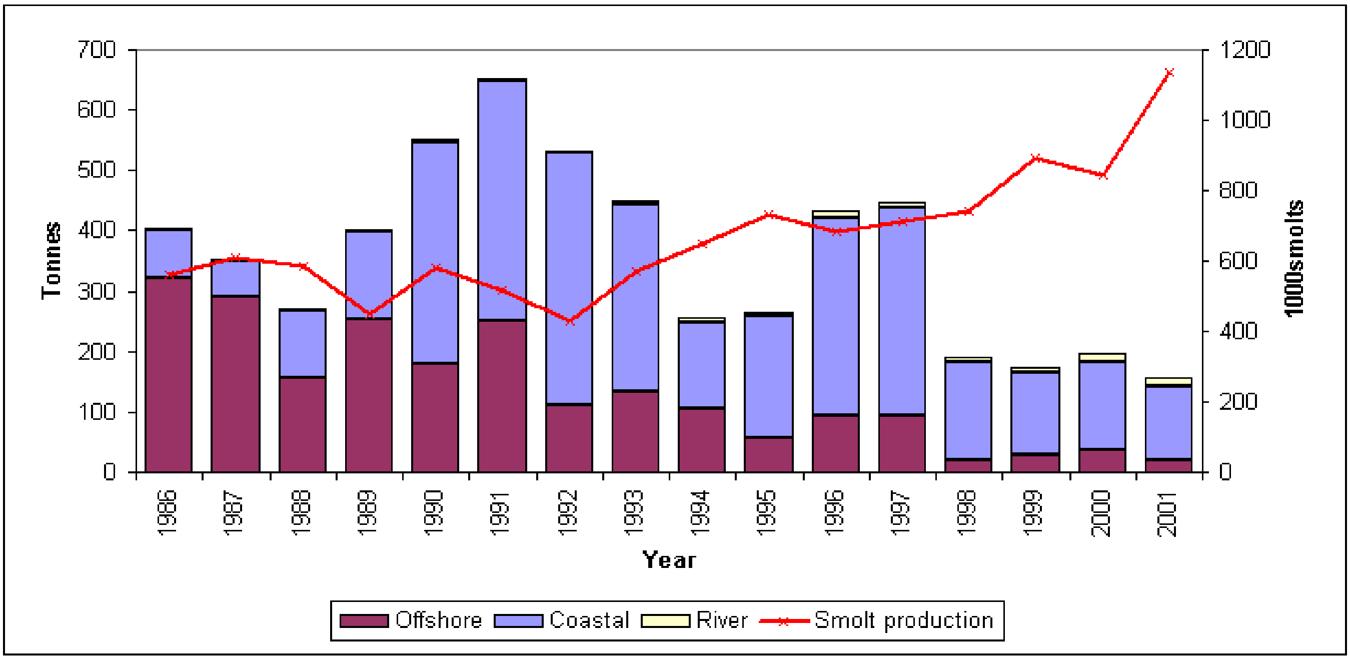


Figure 3.14.16.1. Salmon catches and smolt production in the Gulf of Finland in 1987-2000.

3.14.17 Sea trout

State of stocks/exploitation:

Wild stocks: Currently approximately 400 rivers in the Baltic Sea support wild populations of sea trout. There are no estimates of the original number of sea trout populations or quantitative estimates of the total natural smolt production. Stocks in several rivers in the Main Basin are considered to be in good or satisfactory condition with nursery areas well utilised. However, populations in numerous small Danish brooks are assessed to be in poor condition. In the Gulf of Bothnia the status of most stocks, particularly in Subdivision 31, is poor or unknown (Table 3.14.17.1). Several of these populations are probably overexploited to the extent that they now mainly exist as non-migratory brown trout.

Reared stocks: Sea trout smolt production is shown below (in thousands):

Year	Baltic Main Basin	Gulf of Bothnia	Gulf of Finland	Total
1987	994	1081	358	2433
1988	1312	1083	226	2621
1989	1537	906	198	2641
1990	1237	1035	237	2509
1991	665	1186	259	2110
1992	1023	1247	314	2584
1993	1576	1171	251	2998
1994	1485	985	285	2755
1995	1967	1243	378	3588
1996	1509	1416	139	3064
1997	2726	970	220	3916
1998	2545	943	378	3866
1999	2506	971	355	3832
2000	1825	987	353	3164
2001	2397	1076	488	3961

Elaboration and special comment: The production of sea trout in the Baltic Sea is dominated by reared production to an extent similar to the production of salmon.

Sea trout stocks in the Baltic Sea exhibit two types of migration pattern. Most of the stocks migrate in the coastal area within about 150 km of the point of release, but particularly those from Poland and some from southern Sweden migrate further into offshore areas. The fish that migrate only short distances are mainly exploited in coastal and river fisheries, and they are also affected by the coastal salmon fisheries. Fish that migrate offshore are to a large extent taken as a by-catch in the offshore salmon fishery. The stocks remaining in coastal waters are only exploited in local fisheries and may therefore be managed on a national or local basis, but the stocks migrating into offshore areas would benefit from international management measures. It is not known to what extent stocks in southern Sweden migrate to offshore areas. The management of many of these populations would benefit from knowledge of their migration pattern.

The exploitation pattern is rather variable in different areas. In the Gulf of Bothnia and Gulf of Finland sea trout are to a large extent caught in gillnets for whitefish, and to a minor extent in a recreational net fishery or in trapnets. National management agencies around the Gulf of Bothnia and Gulf of Finland should consider changes in local fishery regulations as well as implementation of restoration programs to improve the status of these sea trout populations, which are in a poor state.

Source of information: Report of the Baltic Salmon and Trout Assessment Working Group. 3 – 12 April 2002 (ICES CM 2002/ACFM:13).

Catch data[2] (Table 3.14.17.2):

Year	Baltic Main Basin	Gulf of Bothnia	Gulf of Finland	Total
	t	t	t	t
1987	319	150	184	653
1988	331	282	290	903
1989	460	331	298	1089
1990	794	432	337	1563
1991	613	463	297	1373
1992	611	469	322	1402
1993	901	250	718	1869
1994	769	190	648	1607
1995	647	227	119	993
1996	511	238	95	844
1997	474	238	93	805
1998	741	252	159	1152
1999	898	319	104	1321
2000[1]	1046	325	93	1464
2001	864	288	79	1231

[1]Preliminary data. [2]No catch advice is given for sea trout. Catch figures do include recreational fisheries only for some countries.

Table 3.14.17.1 Status of monitored wild and mixed sea trout population in 2001.

	Poor	Satisfactory	Good	Not known	Total number
Gulf of Bothnia					
Subdiv 31					
Finland	1	1			2
Finland/Sweden		1			1
Sweden	10	2			12
Subdiv 30					
Sweden	13	9	1	15	38
Finland		1			1
Main Basin					
Sweden	25	23	11	15	74
Estonia	2	5	1	13	21
Latvia	2	5	8		15
Lithuania					
Poland	9	9	5	1	24
Danmark (Subdiv 22-25)	77	53	20		150
Russia				5	5
Gulf of Finland					
Finland	5				5
Russia				15	15
Estonia	7	5	4	23	39
Total	**151**	**114**	**50**	**87**	**402**

Table 3.14.17.2 Nominal catches (tonnes) of sea trout in the Baltic Sea. S=Sea, C=Coast and R=River.

Year	Baltic Main Basin													Gulf of Bothnia					Gulf of Finland			Total
	Denmark[1,4]	Estonia	Finland[2]	Germany[4]	Latvia	Lithuania		Poland			Sweden[4]			Finland[2]		Sweden			Estonia	Finland[2]		
	S + C	C	S + C	C	C	S	C	S[9]	S + C	R	S[6]	C[6]	R	S+C	R	S[6]	C[6]	R	C	C	R	
1979	3	na	10	na	na	na	na	na	81[3]	24	na	na	3	6	na	na	na	na	na	73	0	200
1980	3	na	11	na	na	na	na	na	48[3]	26	na	na	3	87	na	na	na	na	na	75	0	253
1981	6	na	51	na	5	na	na	na	45[3]	21	na	na	3	131	na	na	na	na	2	128	0	392
1982	17	na	52	1	13	na	na	na	80	31	na	na	3	134	na	na	na	na	4	140	0	475
1983	19	na	50	na	14	na	na	na	108	25	na	na	3	134	na	na	na	na	3	148	0	504
1984	29	na	66	na	9	na	na	na	155	30	na	na	5	110	na	na	na	na	2	211	0	617
1985	40	na	62	na	9	na	na	na	140	26	na	na	13	103	na	na	na	na	3	203	0	599
1986	18	na	53	na	8	na	na	na	91	49	7	9	8	118	na	1	24	na	2	178	0	566
1987	31	na	66	na	2	na	na	na	163	37	6	9	5	123	na	1	26	na	na	184	0	653
1988	28	na	99	na	8	na	na	na	137	33	7	12	7	196	na	na	44	42	3	287	0	903
1989	39	na	156	18	10	na	na	na	149	35	30	17	6	215	na	1	78	37	3	295	0	1,089
1990	48[3]	na	189	21	7	na	na	na	388	100	15	15	10	318	na	na	71	43	4	334	0	1,563
1991	48[3]	1	185	7	6	na	na	na	272	37	26	24	7	349	na	na	60	54	2	295	0	1,373
1992	27[3]	1	173	na	6	na	na	na	221	60	103	26	1	350	na	na	71	48	8	314	0	1,402
1993	59[3]	1	386	14	17	na	na	na	202	70	125	21	2	160	na	na	47	43	14	704[7]	0	1,865
1994	33[8,3]	2	384	15[8]	18	+	+	na	152	70	76	16	3	124	na	na	24	42	6	642	0	1,607
1995	69[8,3]	1	226	13	13	+	3	na	187	75	44	5	11	162	na	na	33	32	5	114	0	993
1996	71[8,3]	2	76	6	10	+	2	na	150	90	93	2	9	151	25	na	20	42	14	78	3	844
1997	53[8,3]	2	44	+	7	na	2	na	200	80	72	7	7	156	12	na	16	54	8	82	3	805
1998	60	2	103	4	7	na	na	208	184	76	88	3	6	192	12	0	9	39	6	150	3	1,152
1999	110[8,3]	2	84	9	10	0	1	384	126	116	51	2	3	248	12	0	18	41	8	93	3	1,321
2000	58	4	92	9	14	0	1	443	299	70	42	4	3	263	12	0	14	36	10	75	3	1,452
2001[5]	54	2	62	na	2	0	1	462	243	11	23	1	3	223	7	0	14	44	8	68	3	1,231

[1]Additional sea trout catches are included in the salmon statistics for Denmark until 1982 (Table 3.1.2).
[2]Finnish catches include about 70 % non-commercial catches in 1979 - 1995, 50 % in 1996-1997, 75% in 2000-2001.
[3]Rainbow trout included.
[4]Sea trout are also caught in the Western Baltic in Subdivisions 22 and 23 by Denmark, Germany, and Sweden.
[5] Preliminary data.
[6]Catches reported by licensed fishermen and from 1985 also catches in trapnets used by nonlicensed fishermen.
[7]Finnish catches include about 85 % non-commercial catches in 1993.
[8]ICES Subdiv. 22 and 24.
+ Catch less than 1 tonne.
[9]Catches in 1979-1997 included sea and coastal catches,since 1998 costal (C) and sea (S) catches are registered separately
na=Data not available.

815

3.14.18 Answer to Special Request from IBSFC on selectivity in Cod trawls

IBSFC has requested ICES to:

Evaluate the findings of the IBSFC Scientific Meeting on Technical Measures for the Cod Fisheries in the Baltic (Brussels, August 2001) and inter alia.

- *Review all information relevant to selectivity of gears used for cod fishing in the Baltic Sea*
- *Revisit the selection properties of the 130 mm diamond mesh size and the 125 mm polyamide diamond mesh size codends*
- *Estimate the codend mesh size of a diamond mesh and of a polyamide diamond mesh giving selectivity properties corresponding to the 120 mm BACOMA window trawl*
- *Assess the consequences of the improvements in gear selectivity and of other technical measures as adopted by IBSFC in March and in September 2001*
- *Revise the precautionary reference points for cod, taking into account the changed exploitation pattern*

ICES reviewed the report referred to in the request. There are more data available than were reviewed at the Brussels meeting; however, conclusions on selectivity properties of the cod trawl were not appreciably changed. The Brussels report is based on a standard approach to such assessments, and the approaches and methodology used in the calculations of gains and losses presented below are the same.

ICES considers that in assessing the possible consequences of the new IBSFC fishing rules, only the changes, which apply to towed gears, should be considered. The changes to gillnet regulations are small and little information is available on current practices by the gillnet fleet; so it is not possible to evaluate whether the changes in gillnet regulation will have any practical effect. The effects of other technical measures such as area and seasonal closures are also considered to give little effect on the overall annual fishing mortality. The effects of these measures are therefore not considered further in this answer.

As was done in the Brussels report the assessments, which included discard data are used in the calculations. Compared to the Brussels report these assessments were updated with data for 2001 and benefited from a critical review of the discard data done by ICES in February 2002.

There is considerable uncertainty about how effective the gear regulations measures will be in practice, and how they will improve the exploitation patterns in the Eastern and Western Baltic cod fisheries. ICES will revisit all the reference points in a consistent manner during 2003 and it is therefore considered to be ill-advised to propose a change now. Furthermore, with regard to the existing reference points for both Baltic cod stocks, IBSFC has proposed that all reference points be reviewed on a three-year cycle, which implies that a full review will be done during 2003. It is highly unlikely that it will be possible to evaluate the effects of the new IBSFC fishing rules during 2003, but it may be possible to review other information, which may influence reference points. This includes updated information on the environmental effects on recruitment in the eastern cod stock, which should be available when the STORE project is completed in 2002.

In particular for the eastern Baltic cod even an upward revised $\mathbf{F}_{pa}$ would still be significantly lower than the current fishing mortality. The SSB for eastern Baltic cod is low and is in urgent need of improvement, something that can only be achieved by reducing the overall fishing mortality.

The calculations of losses and gains can only be used as comparisons to no change in selectivity, and not as absolute estimates of any particular stock situation.

It should be stressed that any calculations, which assume the experimentally-derived L50 estimate, must be regarded as an extreme upper limit of the possible effect.

The actual numbers calculated in the Brussels report are not appreciably different from those found in this revisit of the calculations. If, and only if, the new gear regulations are effectively implemented and enforced, they may:

- result in a reduction of discards in both cod stocks
- help in rebuilding the eastern Baltic cod stock
- lead to losses in yield for 2003, but this applies to 2003 only as deemed from simulations. These losses will be balanced by longer-term gains in yield.

Furthermore, this present report discusses the biological reference points and concludes that if the new fishing rules lead to a sustained and substantial improvement to the exploitation pattern, then it may be appropriate to:

- increase the PA fishing mortality reference points, but leave the biomass PA reference points largely unchanged.

But the improved selectivity will not, even when accepting the most optimistic projections be sufficient on its own to achieve the desired rebuilding of the eastern Baltic cod stock, nor will it on its own bring the fishing mortality below what could be expected to be a revised $\mathbf{F}_{pa}$.

Review of all information relevant to selectivity of gears used for cod fishing in the Baltic Sea

ICES compiled the existing information. This is tabulated in the report of the ICES Working Group on Fishing Technology and Fish Behaviour - Review of the Size Selectivity of Baltic Cod Trawls, 7-9 February 2002, available on the ICES website (under the Fishing Technology Committee) and upon request from the IBSFC or ICES Secretariats, use the e-mail address info@ices.dk for ordering copies.

Selection properties of a 120 mm BACOMA window

ICES scrutinised the existing information (all of which was available to the Brussels meeting) and estimated L50 for a 120 mm BACOMA window at 45.24 cm. This value is very similar to that used at the Brussels meeting (45.96 cm).

Selection properties of the 130 mm diamond mesh size

ICES scrutinised the existing information and constructed the analysis presented in Figure 3.14.18.1. In total 24 experiments is included in this analysis while the analysis presented in the Brussels report was based on only 10 of these experiments. The estimated L50 for 130 mm diamond mesh size cod end was 40.85 cm. This value is very similar to that used at the Brussels meeting (40.3 cm).

The BACOMA experiment showed that the selectivity varies with vessel type and the analysis presented above include all vessels categories. The analysis was therefore repeated restricting the data to only stern trawlers. This gave an L50 at 130 mm at 40.33 cm.

Selection properties of the 125 mm polyamide diamond mesh size

Data were available for 6 experiments, but these data included such a variety of nominal twine sizes that it was considered impossible to model the selectivity of these codends in terms of twine and mesh size. As a consequence, the selectivity of a 125mm mesh, 4.5mm, single-strand, polyamid codend cannot be determined with the available data.

Codend mesh size of a diamond mesh giving selectivity properties corresponding to the 120 mm BACOMA window trawl

See results in Table 3.14.18.1. and Figure 3.4.18.1.

Table 3.14.18.1 Estimated diamond mesh size needed to produce the same L50 as a trawl with a 120-mm BACOMA window.

Vessel type	Mesh size (mm)	Standard deviation	95% Confidence Interval (mm)
Combined trawlers	140	3.19	134-147
Stern trawlers	142	3.4	135-149

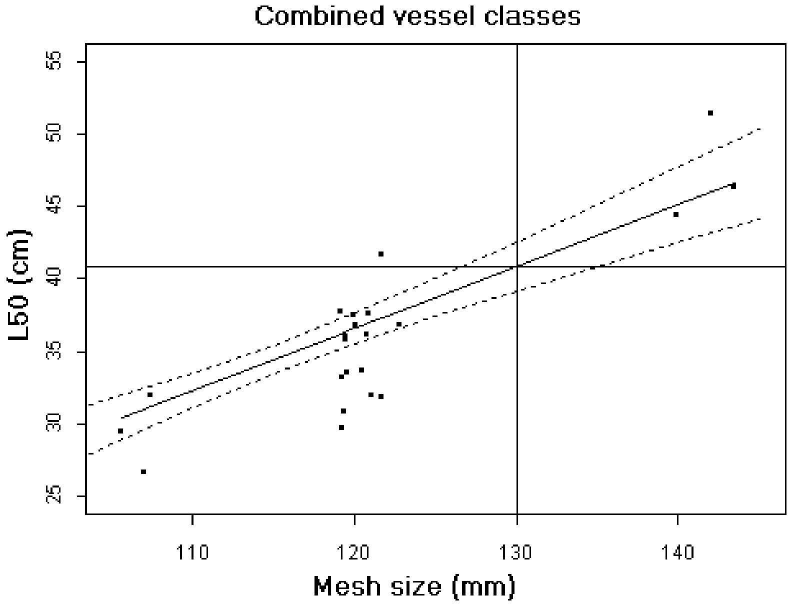


Figure 3.4.18.1 L50 versus codend mesh size for diamond mesh experiments – All vessel classes combined. The solid line represents the predicted mean value of L50; the dashed line indicates the 95% confidence intervals. Also shown is the value of L50 at a codend mesh size of 130 mm.

Consequences of the improvements in gear selectivity and of other technical measures as adopted by IBSFC in March and in September 2001

In assessing the possible consequences of the new IBSFC fishing rules, only the changes, which apply to towed gears, were considered. The changes to gillnet regulations are small and little information is available on current practices by the gillnet fleet; so it is not possible to evaluate whether the changes in gillnet regulation will have any practical effect.

The possible effects of the new gears were evaluated in detail at the scientific meeting in Brussels, and the approaches and methodology used here are the same. Side trawlers take most of the catch of cod.

It should be stressed that any calculations, which assume the experimentally derived L50 estimate, must be regarded as an extreme upper limit of the possible effect.

To evaluate the possible effects of changes in gear on the Baltic cod stocks and fisheries, it is necessary to model the relevant population and selection processes, and to then run the models using appropriate parameter estimates, including estimates of both the selectivity of the new gears and of the gears currently in use.

Selectivity estimates for the new gears are available from selectivity trials (see above). However, information about the effective selectivity of the gears currently in use by the trawl fleet is not readily available as it is not clear to what extent the selectivity of gears actually in use reflects the experimental results obtained using the current minimum mesh size. Although estimates of the effective selectivity of current gears are not available, it is possible to determine the bounds within which the current selectivity may lie. At one extreme, the gears may be highly unselective, with the exploitation pattern effectively determined only by the relative availability of each age group. At the other extreme, the selectivity of the current legal minimum mesh size, as estimated in experimental trials, represents the upper bound on the effective selectivity of current gears. As the actual effects are likely to lie somewhere between these two extremes, the run was made assuming the median position that 50% of trawlers are effectively unregulated in terms of their selectivity, and that the other 50% are using gears with selectivity characteristics corresponding to the experimental estimates for 120 mm diamond mesh (i.e. L50 = 37.2 cm, SR = 9 cm). To represent the selectivity of the new gears, it has been assumed that all trawlers adopt the 120 mm BACOMA gear; hence a run has been made assuming that from 2003 100% of trawlers use the 120 mm BACOMA window (L50 = 45.2 cm, SR = 6.7 cm). It is assumed in both cases that these measures are fully implemented and enforced. In all cases the selectivity of the gillnet fleet is assumed to be unchanged. In the absence of information on the proportion of stern and side trawlers in the Baltic fleets, and on the selectivity of the BACOMA gear when operated by side trawlers, the BACOMA value estimated for stern trawlers has been assumed to apply for all trawlers.

The runs can only be used as comparisons to the baseline (i.e. no change in selectivity).

The assessments, which included discard data are used in the calculations.

Cod in the Western Baltic (Subdivisions 22-24)

The forecast, assuming the selectivity change takes place at the beginning of 2003, indicates that 2003 landings would be 26% lower, but that 2004 landings would be about the same as if no selectivity change was introduced. The 2004 SSB would be 40% higher in the case of a selectivity change.

Cod in the Western Baltic (Subdivisions 22-24)

Summary of results of technical measure forecast compared to baseline

Short-term percentage changes

	2003	2004	2005	2006	2007
Landings (weight)	-26.20%	2.99%	26.62%	36.61%	40.38%
Discards (weight)	-52.99%	-44.66%	-43.66%	-43.63%	-43.63%
Discards (Nos.)	-62.60%	-57.18%	-56.66%	-56.65%	-56.65%
SSB	0.00%	40.05%	78.01%	95.25%	101.12%

Long-term (eqm) change

Landings-per recruit (weight)	42.33%
Discards per recruit (weight)	-43.63%
SSB per recruit	104.25%

Fishing Mortality

Before selectivity change

Age	Landings	Discards	total
1	0.046	0.109	0.155
2	0.492	0.201	0.693
3	1.153	0.064	1.217
4	1.346	0.003	1.349
5	1.205	0.000	1.205
6	1.140	0.000	1.140
7	1.140	0.000	1.140
8	1.140	0.000	1.140
Fbar (3-6)			1.228
Fbar (1-3)			0.688

After selectivity change

Age	Landings	Discards	total
1	0.010	0.023	0.033
2	0.208	0.082	0.291
3	0.780	0.041	0.820
4	1.252	0.003	1.255
5	1.181	0.000	1.181
6	1.139	0.000	1.139
7	1.140	0.000	1.140
8	1.140	0.000	1.140
Fbar (3-6)			1.099
Fbar (1-3)			0.381

	Fbar (3-6)	Fbar (1-3)
Before	1.228	0.688
After	1.099	0.381
% change	-11.74%	-80.52%

Cod in the Eastern Baltic (Subdivisions 25-32)

The forecast, assuming the selectivity change takes place at the beginning of 2003, indicates that 2003 landings would be 17% lower, but that 2004 landings would be about the same as if no selectivity change was introduced. The 2004 SSB would be 23% higher in the case of a selectivity change.

Summary of results of technical measure forecast compared to baseline

	Short-term percentage changes				
	2003	**2004**	**2005**	**2006**	**2007**
Landings (weight)	-17.52%	1.47%	13.43%	20.16%	23.45%
Discards (weight)	-82.34%	-81.73%	-81.70%	-81.60%	-81.60%
Discards (Nos.)	-83.53%	-83.26%	-83.25%	-83.22%	-83.22%
SSB	0.00%	22.66%	38.83%	47.61%	52.06%

	Long-term (eqm) change
Landings-per recruit (weight)	25.08%
Discards per recruit (weight)	-81.60%
SSB per recruit	54.55%

Fishing Mortality

Before

Age	Landings	Discards	total
2	0.077	0.052	0.129
3	0.455	0.039	0.494
4	0.915	0.002	0.917
5	1.287	0.002	1.289
6	1.001	0.000	1.001
7	0.982	0.000	0.982
8	0.982	0.000	0.982
Fbar (4-7)			1.047
Fbar (2-4)			0.513

After

Age	Landings	Discards	total
2	0.024	0.011	0.035
3	0.264	0.001	0.266
4	0.613	0.001	0.614
5	1.100	0.002	1.102
6	0.979	0.000	0.979
7	0.979	0.000	0.979
8	0.982	0.000	0.982
Fbar (4-7)			0.918
Fbar (2-4)			0.305

	Fbar (4-7)	Fbar (2-4)
Before	1.047	0.513
After	0.918	0.305
% change	-14.02%	-68.44%

Revise the precautionary reference points for cod taking into account the changed exploitation pattern

There is considerable uncertainty about how effective the new gear regulations will be in practice. Furthermore, it will not be possible to evaluate whether they have had any effect until after the regulations have been in force for a number of years. As a result it would be premature to propose revisions to reference points, which account for these possible effects. In addition, ICES will revisit all the reference points in a consistent manner during 2003 and therefore it is considered to be inappropriate to propose a change now. However, some considerations on how the reference points could change if the estimated possible improvement in exploitation pattern is achieved are presented below for illustration.

ICES uses reference points defined in terms of spawning stock biomass and of fishing mortality.

The $\mathbf{B}_{lim}$ reference points are not affected by the selectivity change as these represent estimates of SSB when recruitment will be impaired. Discards are expected to be much reduced and this will increase the estimates of recruitment in absolute terms, but not the point when the recruitment is impaired.

The $\mathbf{B}_{pa}$ reference point is the $\mathbf{B}_{lim}$ plus a buffer added to the $\mathbf{B}_{lim}$ reference point to reflect assessment uncertainty and stock variability. Assessment uncertainty is largely determined by the accuracy of the fisheries statistics, the amount of sampling made from the landings and catches, and the accuracy and precision of the abundance surveys. The elements are not affected by the improved selectivity. Stock variability may be reduced at higher spawning stock biomasses, but this is speculative and is not demonstrated for the cod stocks. Hence, the $\mathbf{B}_{pa}$ reference point will not change as a primary effect from the selectivity change.

The fishing mortality reference points $\mathbf{F}_{\mathbf{lim}}$ and $\mathbf{F}_{\mathbf{pa}}$ both depend on the exploitation pattern, which in turn is affected by the gear selectivity. Depending on the assumptions made about how the exploitation pattern will alter, the estimated change in F reference points will vary. Some insight into the general magnitude of possible effects can be obtained by examining the SSB-per-recruit at a range of F's under various assumed selectivity patterns, and finding the cases matching the SSB-pre-recruit from the existing reference points and exploitation pattern. The analyses suggest that F reference points could increase by 20-50%, depending on how the exploitation pattern will change. A revision of reference points on this basis would only be appropriate if the new fishing rules lead to a sustained and substantial improvement in the exploitation pattern. It will not be possible to evaluate this until after the new regulations have been in place for a number of years. However, the improvement in exploitation pattern would require that the more selective trawls are accepted and effectively implemented by all trawlers. There are strong indications that the new gears have not been accepted, so their implementation has not been effective.

Final Comment

With regard to the existing reference points for both Baltic cod stocks, IBSFC has proposed that all reference points be reviewed on a three-year cycle, which implies that a full review will be done during 2003. It is highly unlikely that it will be possible to evaluate the effects of the new IBSFC fishing rules during 2003, but it may be possible to review other information, which may influence reference points.

Source of information: Report of the IBSFC Scientific Meeting on Technical Measures for the Cod Fisheries in the Baltic, Brussels, August 2001.

Report of the ICES Working Group on Fishing Technology and Fish Behaviour - Review of the size selectivity of Baltic cod trawls, 7-9 February 2002 (ICES CM 2002/B:1).

Report of the Baltic Fisheries Assessment Working Group, 15 – 24 April 2002 (ICES CM 2002/ACFM:17).

3.14.19 Answer to special request from IBSFC on Pelagic Fisheries

Regarding pelagic fishery catches in the Baltic IBSFC requested ICES to:

- *Review national sampling programmes of these catches and by fleet evaluate the uncertainties of the estimated species composition and age compositions.*

- *Provide an overview of the spatial and seasonal distribution of these catches by species and by fleet.*

- *Consider and evaluate the impact on SSB and yield by introducing minimum landing size for herring and sprat (herring – 16 cm, sprat – 10 cm) and the by catches of juvenile herring in herring-directed fishery (15%), the by-catches of juvenile sprat in sprat-directed fishery (15%), and by-catches of herring in sprat-directed fishery (15%).*

The answers to the first two points have been delayed and an answer is expected in mid-June 2002.

Impact on SSB and yield by introducing a minimum landing size for herring and sprat (herring 16 cm, sprat 10 cm) and the by-catches of juvenile herring in herring-directed fishery (15%), the by-catches of juvenile sprat in sprat-directed fishery (15%) and by catch of herring in sprat-directed fishery (15%).

A minimum landing size for herring and sprat will only affect SSB if the small herring and sprat that are not landed are also not caught. Generally, herring and sprat do not survive once brought on deck and returned to the sea. Therefore, a minimum landing size rule in itself will not affect SSB. Obviously the amount of herring and sprat discarded would be lost to the yield.

Mesh size regulations in the trawl fishery cannot be used effectively to regulate mortality of herring and sprat due to the poor survival of escapees. A mortality of 80% or higher for herring has been observed. No survival experiments have been carried out for gillnet fishing. However, even in this case it is likely that the survival of the herring escaping from the gillnet is not 100 %.

Closed areas or closed seasons are only effective management measures if there are areas that can be closed and that contain relatively large numbers of small fish. Such areas have only been identified in parts of the Baltic Sea.

Concerning sprat, there is large variability in area distribution both during the year and between years. This means, that a fixed closed area system cannot be used to manage the fishing mortality of the sprat stock.

Concerning herring the differences in length distributions between the different areas are more stable than in the case of sprat. An effective way to decrease the fishing mortality of young herring would be to fish only during the spawning migration on or near spawning grounds. This implies, however, a closed season for herring for more than 3/4 of the year.

A possible implementation of improving the selectivity of the fishery would be to prohibit landings when and where the proportion of fish under a certain size is too high. In such a system the fishermen are responsible for finding areas where small herring and sprat do not occur in the catches. This type of regulation has been applied in Poland. However, no analysis has been made to support the implementation of such a management measure.

Herring spawns on the coast, and during that time of the year the fishery is targeted on the spawning migrating fish on the coast (e.g. trapnet fishery). This fishery is more beneficial from the conservation point of view than the fishery which targets the immature part of the stock.

Table 3.14.19.1 gives the theoretical upper limit on the long-term maximum gain that could be obtained if fishing mortality on age 0 or age 1 herring could be reduced to zero. This would have the effect of increasing the SSB by 20%, but the possibility of increasing the yield-per-recruit is very small. The likely gain from any regulation that reduces the catch of juvenile herring and sprat are less than the theoretical maximum gains indicated.

How much of the fishery is conducted with by-catches outside the limits indicated?

There are significant fluctuations between years in the amounts of immature sprat, varying between 10 and 65% of the total catch. The fluctuations are determined by the strength of the sprat year classes that may fluctuate considerably in different years. The share of immature sprat varies significantly by Subdivisions as well, and reaches the greatest values in Subdivision 22. The share of immature herring in the total stock is more stable compared to sprat as a result of lower fluctuations of herring year class strength. The smallest proportion of immature herring is observed in Subdivision 27 and the highest proportion in Subdivision 32.

Juvenile fish are especially abundant in industrial catches. In Subdivision 26 up to 63% in weight of catch has been observed to be juvenile herring. Juveniles are unevenly distributed; the amount of juveniles was approximately 2–3 times higher in catches on coastal fishing grounds compared to the open sea catches. Occurrence of juvenile herring increases especially in the IV and I quarter of the year, when young and older fish form mixed shoals and the sprat fishery intensifies.

Conclusions and advice

In the case of sprat, there seems to be no realistic way to implement a change in exploitation pattern without detailed and locally adapted rules. In the case of herring, a fishery targeted on the spawning migrating fish would theoretically offer a possibility to manipulate the exploitation pattern.

Table 3.14.19.1 The relative changes in spawning biomass and yield of herring if fishing could be closed for age groups 0 and 1. Calculation based on the Central Baltic herring stock (Subdivisions 25-29 and 32 excl. Gulf of Riga).

Variable	No change	No fishing in age 0	No fishing in ages 0 and 1
SSB	1	1.06	1.20
Yield	1	1.05	1.06

3.14.20 Answer to Special Request from IBSFC on Research Plan for Central Baltic Herring

IBSFC has requested ICES to:

Develop a research programme aimed to improve management of Central Baltic herring stocks through enhancing our knowledge regarding their structure and dynamics. The programme should include:

1. *Review the existing information on stock structure and migration patterns and plan a sampling programme of the commercial fisheries for splitting their catches into stock components;*

2. *Review stock separation methodologies and draw up a research plan for a sampling and analysis programme. The programme should include a validation component of the stock separation procedures;*

3. *Adapt surveys to provide abundance indicators for use in the stock assessment of individual stocks;*

4. *Develop stock assessment models of individual stocks, taking into account fleet behaviour and fish migrations. Based on such models compile relevant time series;*

5. *Evaluate alternative management systems, e.g., effort limitation, closed areas, which reflect individual trends among populations. Propose a monitoring system of the commercial fisheries for splitting catches into stock components.*

The IBSFC request contains several sub-components related to the Baltic herring stocks, and these topics can potentially be addressed by a wide range of activities. These activities will require an allocation of resources (e. g., shiptime, manpower, improved technologies) from national laboratories and funding agencies. The resources available in the future will therefore determine the scope of any such research programme that can be established. At the present time it is unclear what those resources might be and when they will become available. In the absence of this information it is not possible to define the specifics of a new research programme.

Nevertheless, it is possible to identify research activities that would address the topics in the request when such resources become available. This information could be used to highlight important research needs and priorities to national laboratories and funding agencies (e.g., EU), and might encourage those organisations to allocate the resources required to conduct such a research programme.

The five topics raised in the IBSFC request are to some extent linked and cannot be conducted simultaneously in an effective manner. This is because results and information from some of the topics are needed to address some other topics. This means that the topics must be addressed sequentially. It is proposed that the first three topics be addressed first, and that results and information from these be used to investigate the last two topics.

It is also recognized that the issue of stock separation methodology is a topic of investigation in the wider ICES community and is being investigated by a dedicated study group (Study Group on Stock Identification Methods; Chair: Kevin Friedland). This Study Group will produce a manual on stock separation methodologies and techniques in 2003. Its guidelines and recommendations should be considered when attempting to define new stock units for Baltic herring.

Elements of the new research programme:

Topics 1 and 2:

Topics 1 and 2 of the research programme suggested by IBSFC have been addressed by the Study Group on Herring Assessment Units in the Baltic Sea (SGHAUB). This Study Group identified several gaps in the present knowledge of the herring stock structure in the Baltic, and some actions that could be taken to close those gaps. These actions would address in particular topics 1 and 2 in the research programme and therefore could form the basis of such a research programme. The actions proposed by the Study Group are given in Section 4 of its report and were used to answer this request.

Ongoing and new genetic studies will also address issues, including the validation, of stock separation and structure/dynamics. The results of genetic research initiated recently on Baltic herring using microsatellite markers are important for planning any future programmes and could serve as a platform for future investigations, on an international scale. National laboratories are already contributing biological material to these investigations, and results from these studies could be used to develop specific sampling methods for identifying particular stocks and stock subcomponents, and their dynamics.

The Study Group has outlined a sampling and analysis strategy for stock separation purposes. This strategy is given in Section 5 of the Study Group report and addresses topic 2.

In addition to these activities, knowledge of factors affecting the reproductive success in different spawning areas would be useful for stock separation purposes and understanding. The following topics should be investigated:

a) the state of the spawning grounds and the success of embryonic development;
b) the utilization of the spawning grounds by analyzing information on herring coastal fishery during the spawning period (e.g., in trapnet fishery the number of trapnets, landings);
c) representative herring otolith samples from the spawning grounds and their further analysis by modern methods that could give new possibilities for stock separation and validation. It should be pointed out that embedded otoliths, which are an adopted preparation practice in some laboratories, are not useful for these purposes.

The above activities, if implemented, would address in particular the first 2 topics of the research programme request from IBSFC.

Topic 3:

The following activities address topic 3:

1) Expand the International Hydro-Acoustic Survey to SD 29 North and SD 32. This would be useful both for the assessment in SD 25–29, 32 (Gulf of Riga herring excluded) and potential assessment in SD 28, 29, and 32.

2) SGHAUB should finalize the compilation of data for the assessment of southern coast herring in SD 25–26 and Swedish coast herring in SD 25–27. For these two assessments the separation of catches by population is performed only by Poland and Russia; catches of other countries are split on the base of age and population composition in Polish and Russian catches. Therefore SGHAUB has recommended that samples from Danish and

3) Swedish herring fishery in these subdivisions are submitted to Poland (SD 25) and Russia (SD 26) for direct determination of population structure. SGHAUB should carry out exploratory assessments of these herring stocks as well as for herring in SD 28 (Gulf of Riga herring excluded), 29, and 32, and present the results to the ICES Baltic Fisheries Assessment Working Group. Besides, it is important that for these assessments the national data are prepared and data series are checked.

4) The data on fish abundances from the International Hydro-Acoustic Survey could be used for the analysis of the herring distribution pattern during feeding migrations, detecting regularities in the distribution, and the influence of hydrological peculiarities and stock size on the distribution pattern. Biological sampling from the surveys could be used for judging whether the migration pattern inferred by the old tagging experiments is still valid. This information will also provide background information for topic 4.

Topics 4 and 5:

These topics depend on an improved understanding of stock structure and dynamics that will be developed over the next several years, if the research to address topics 1–3 is conducted.

The results of the studies addressing topics 1–3 would provide the necessary information for evaluating topics 4 and 5 (e.g., assessment models accounting for migrations, management systems including closed areas and effort limitation).

3.14.21 Response to request from Finland concerning revision of the assessment of herring in Subdivision 30 (Bothnian Sea)

ICES has been asked to consider:

- Evaluation of the quality and correctness of the new stock assessment of Baltic herring stock in the Bothnian Sea (ICES subdivision 30, IBSFC Management unit 3)
- Revision of advice, if necessary on catch options for 2002 based on fishing mortalities in the fishing mortality range F=0.15 to 0.30, as considered appropriate
- Guidance on management strategies in terms of spawning stock biomass and mortality rates under different management scenarios in medium term

Finland requested a response by 15 March 2002.

1.Background

The fishery is virtually entirely Finnish. The re-assessment is based on revised data for 2000 for Finland but maintains the basic approach adopted by the Working Group on Baltic Fisheries Assessment (WGBFAS) and as accepted by ACFM. The basis for the updates is that final Finnish data for 2000 only became available after ACFM met in May 2001. Compared with the data used in the assessment on which ACFM based its advice in May 2001, catches for 2000 were decreased by about 9%, age compositions were unchanged while CPUE data for the three tuning fleets were increased with 20–25%.

2. Evaluation of the correctness of the new stock Assessment

The assessment is based on catch at age in numbers and CPUE series from commercial fisheries for three fleets. The effort data were updated as follows, the relative changes given below were calculated as the difference between new -old of the effort estimates have been changed (%) as shown below.

	Pel. Trawl	Bottom Trawl	Trap nets
% change of effort (new-old)*100/[(new+old)/2]	-26.9	-21.8	-22.4

This means that CPUE is increased thus indicating a larger stock than hitherto estimated.

Maris Plishs (chair WGBFAS) and Hans Lassen (ICES Fisheries Adviser) have confirmed the Finnish calculations.

The estimated fishing mortality and recruitment differ between the old (ACFM May 2001) assessment and the revised assessment as illustrated below (changes before 1993 are all less than 1 %).

Year	Recruitment (age 1)			Fishing Mortality (F-bar)		
	Old Assessment (Table 11.7.2)	New Assessment	Rel. Difference % (=(new-old)*100/[(old+new)/2]	Old Assessment (Table 11.7.2)	New Assessment	Rel. Difference % (=(new-old)*100/[(old+new)/2]
1993	5,476,167	5,539,460	1.1	0.1251	0.1248	-0.2
1994	3,630,441	3,732,809	2.8	0.1881	0.1873	-0.4
1995	4,671,458	4,788,830	2.5	0.2089	0.2076	-0.6
1996	3,884,651	4,086,477	5.1	0.1891	0.1865	-1.4
1997	3,446,769	3,762,311	8.8	0.2373	0.2323	-2.1
1998	6,123,975	7,070,230	14.3	0.2219	0.2147	-3.3
1999	2,579,859	3,058,594	17.0	0.2857	0.2691	-6.0
2000	4,664,747	4,832,528	3.5	0.3021	0.2473	-19.9

The new assessment gives higher estimates of spawning stock biomass for 2001. The SSB (2001) estimate is 203 000 t in the June 2001 assessment while the revised data suggest an estimate of 264 000 t. Correspondingly, the fishing mortality for 2000 is found to be lower in the revised assessment compared to the assessment made in June 2001.

The precautionary approach reference points are $\mathbf{F}_{pa}$ = 0.21 and $\mathbf{B}_{pa}$ = 200,000 t.

3. Revision of advice, if necessary on catch options for 2002 based on fishing mortalities in the fishing mortality range F=0.15 to 0.30, as considered appropriate

The June 2001 ICES advice for management of the fishery in 2002 is given below including the catch option table.

Advice on management (June 2001): ICES recommends to reduce the fishing mortality to no more than F_{pa}, [F_{pa} = 0.21] corresponding to landings of less than 39 500 t in 2002.

Catch forecast for 2002: Basis: F(2001) = F(98–00) = 0.30, Landings(2001) = 60, SSB(2001) = 203

F (2002)	Basis	SSB (2002)	Landings (2002)	SSB (2003)
0.00	No fishing	201	0	251
0.21	F_{pa} =0.7*F(98–00)	195	39	206
0. 24	0.8*F(98–00)	194	44	200
0.27	0.9*F(98–00)	194	49	194
0.30	F_{lim} =F(98–00)	193	54	189

Weights in '000 t.

Shaded scenario considered inconsistent with the precautionary approach.

The following table gives the revision of short term forecast using new estimates of stock composition as of 1st January 2001 together with fishing mortality, landings and spawning stock biomass for 2001.

Catch forecast for 2002: Basis: F(2001) = F(98–00)= 0.25, Landings(2001) = 54, SSB(2001) = 264

F (2002)	**Basis**	**SSB (2002)**	**Landings (2002)**	**SSB (2003)**
0.00	No fishing	276	0	336
0.19	0.8*F(98–00)	268	50	279
0.21	F_{pa} =0.85*F(98–00)	267	53	275
0.22	0.9*F(98–00)	267	56	273
0.25	1.0*F(98–00)	266	62	267
0.27	1.1.*F(98–00)	265	67	261
0.30	F_{lim} =1.22*F(98–00)	264	72	255

Weights in '000 t.

Shaded scenario considered inconsistent with the precautionary approach.

The updated catch forecast suggests that the TAC for 2002 corresponding to F_{pa} is revised upwards from 39 500 t to 53 000 t. ICES maintains its advice to restrict fishing mortality to no more than F_{pa}[=0.21].

4. Medium Term projections

The medium term projections presented in June 2001 were based on a lower initial stock situation than suggested by the revised assessment. The revision only concerns the present state of the stock and not the entire time series hence the stock recruitment relationship and the perception of the uncertainties in the assessment remain unchanged. The basic features of the medium term projections therefore remains unchanged except for the initial higher starting point.

ICES has not finalised this analysis; the upward revision of the assessment makes the medium term projections for some fishing mortalities dependent on extrapolation of the stock-recruitment relationship to SSB levels for which there are little or no data. WGBFAS will re-analyse these projections and in late May 2002 ACFM will review the results.

5. Management Considerations

This stock is regulated by IBSFC as part of Management unit 3 (= subdivisions 29N+30+31). The central Baltic herring of which only a proportion is found in Subdivision 29N, is decreasing. The herring stock in Subdivision 31 is at a low level with too high fishing mortality.

ICES advice given in June 2001 for the Central Baltic herring and herring in Subdivision 31 is unchanged and not affected by the revision presented above. For convenience these advices are repeated below

Central Baltic Herring

Advice on management: ICES recommends that fishing mortality in 2002 should be reduced below the F_{pa} = 0.17 to allow the SSB to increase. The TAC for herring in Sub-divisions 25–29, 32 should be set so that the catch of this stock in 2002 is less than 73 000 t. To allow the SSB to rebuild to historic sizes associated with good recruitment, a rebuilding plan should be developed.

Herring in Subdivision 31

Advice on management: ICES advises that exploitation rates should be decreased from their recent high levels.

3.15 *Nephrops* Stocks

3.15.1 Overview of *Nephrops* Stocks

Functional Units and Management Areas

Functional Units are defined by groupings of statistical rectangles according to the present knowledge of the distribution of *Nephrops* stocks. Management Areas are defined using, as far as possible, existing ICES Subarea and Division boundaries. ICES provides catch advice by Functional Units. However, under the existing quota system, a TAC is often set for an area that is larger than the Management Area that is considered appropriate. Therefore, the present TAC areas do not allow management of the stocks in individual Functional Units in a way that takes the different levels of exploitation into account. While for some Management Areas it may be advisable to reduce exploitation, it may be admissible to increase catches in other Management Areas included within the same TAC area. If the sum of the recommended catches for the separate areas is taken as the basis for setting the TAC for the whole area, this could lead to unsustainable increases in exploitation in individual Management Areas within the TAC area.

The advice in this report is limited to Subareas VIII and IX, within which the TAC areas are identical to Management Areas. However, ICES takes this opportunity to reiterate the recommendation given in previous years that management should take place at the Management Area level as defined in Figures 3.15.1.1-3.15.1.3 and Table 3.15.1.1. As an alternative, specific management tools could be developed aimed at controlling fishing effort on a much smaller geographical scale than is the case in the existing system. This problem is relevant mainly to the more northern Management Areas, notably those in Subareas IV and VII.

Assessment Methods Employed

The assessment of the stocks was based on a variety of methods:

- Analysis of long-term trends in fishery data (landings, effort, CPUE, LPUE, etc.);
- Age-based analytical assessments (VPA);
- Short-term stock projections based on the output of the VPA;
- Y/R analyses based on the output of the VPA; and
- Fishery-independent surveys (trawl surveys).

The examination of trends in fishery data remains an important element of *Nephrops* assessments, especially for stocks with few biological or sampling data. For most stocks, available information now extends over many years.

Age-based VPAs are performed for all stocks for which there are biological data and a sufficiently long time-series of fishery sampling data. It should be recognised that these assessments suffer from several limitations, including:

- uncertainties in the slicing of length into 'age' distributions;
- the year-to-year variations in emergence of *Nephrops* (which may result in unrealistic estimates of stock biomass, particularly for the females); and
- in a number of cases, the lack of discard data (which results in levelling off the estimates of the recruits and leads to a false impression of stability in recruitment).

Fishery-independent survey data are available for a number of stocks. For the stocks considered in this report, these are trawl surveys, which suffer from two principal limitations:

- low catch rates, owing to the surveys often being directed at monitoring other species, such as hake; and
- catch rates dependent on time of day fished, owing to diurnal activity rhythms of *Nephrops* determining their availability to trawls.

Despite these limitations, trawl surveys can provide useful corroboration of trends observed in commercial catch rates and in the outputs of analytical assessments.

Male vs. Female Exploitation

Female *Nephrops* are less available for exploitation than males. Females are mainly caught in the summer months, but when berried (usually between early autumn and spring of the next year) they stay in the burrows and cannot be caught by trawls. In most stocks, this is reflected by much lower fishing mortality rates and much more optimistic Y/R predictions for females than for males. However, in fisheries where there is a high proportion of effort in the summer, fishing mortality can be as high on females as on males. These stocks are more vulnerable to spawning stock depletion, and there is a greater risk that they will go outside safe biological limits.

Males are the most vulnerable component of the stock (while at the same time accounting for the majority of the landings). Therefore, overall evaluation of the state of exploitation of the stocks, and hence the management advice, is largely based on consideration of the male portions of the stock.

The differences in exploitation pattern between males and females, and the uncertainty about the reliability of the nominal VPA estimates of female stock biomass and recruitment (the trends in these however, are believed to be reliable), are the main reasons why stock biomass and recruitment are given for males and females separately, and not for the sexes combined.

Advice for 2003

ICES provides advice in this report for 2003 only.

Advice is limited to the southern stocks, i.e. stocks in Subareas VIII and IX. In recent years *Nephrops* assessments have been performed biennially, and advice has been given for two-year periods. In the case of these southern stocks, however, the results of assessments performed in 2001 showed serious reasons for concern, and the need was seen to revise the assessments and advice on an annual basis. For all northern stocks, i.e. those to the north of the Bay of Biscay, no such need was identified, and the advice previously given for 2003 remains applicable.

Assessments were performed this year for stocks in the Bay of Biscay (FUs 23+24) and around the Iberian Peninsula (FUs 25, 26+27, 28+29, 30, and 31). These confirm the results of last year's assessments, showing that there is serious reason for concern. At least in Division VIIIc and Subareas IX there is evidence of declining trends in LPUE/CPUE and/or biomass and recruitment, and ICES again proposes that drastic management action should be taken. In view of the continuing alarming state of exploitation of these stocks, advice is given for the year 2003 only, and ICES recommends that these stocks be re-assessed (along with the northern stocks) in 2003.

Table 3.15.1.1 Description of Management Areas together with their *Nephrops* Working Group labels and the Functional Units contained within them.

WG label	ICES description	Functional Units (FUs) or groupings thereof when treated as one in assessments	
A	Va	1	Iceland
B	Vb (non EC)	2	Faeroe Islands
C	VIa	11	North Minch
		12	South Minch
		13	Clyde
D	Vb (EC) + VIb		None
E	IIIa	3	Skagerrak
		4	Kattegat
F	IVa, rect. 44-48 E6-E7 + 44E8	9	Moray Firth
		10	Noup
G	IVa, West of 2° E excl. MA F	7	Fladen
H	IVb,c, East of 1° E excl. rect. 43F5-F7	5	Botney Gut
		33	Off Horn Reef
I	IVb,c, West of 1° E	6	Farn Deeps
		8	Firth of Forth
J	VIIa, North of 53° N	14	Irish Sea East
		15	Irish Sea West
K	VIId,e		None
L	VIIb,c,j,k	16	Porcupine Bank
		17	Aran Grounds
		18	Ireland NW coast
		19	Ireland SW and SE coast
M	VIIf,g,h, excl. rect. 31E1 32E1-E2 + VIIa, South of 53° N	20+21+22	Celtic Sea
N	VIIIa,b	23+24	Bay of Biscay
O	VIIIc	25	North Galicia
		31	Cantabrian Sea
P	VIIId,e		None
Q	IXa	26	West Galicia
		27	North Portugal
		28+29	South-West and South Portugal
		30	Gulf of Cadiz
R	IXb + X		None
S	IVa, East of 2° E + rect. 43F5-F7	32	Norwegian Deep

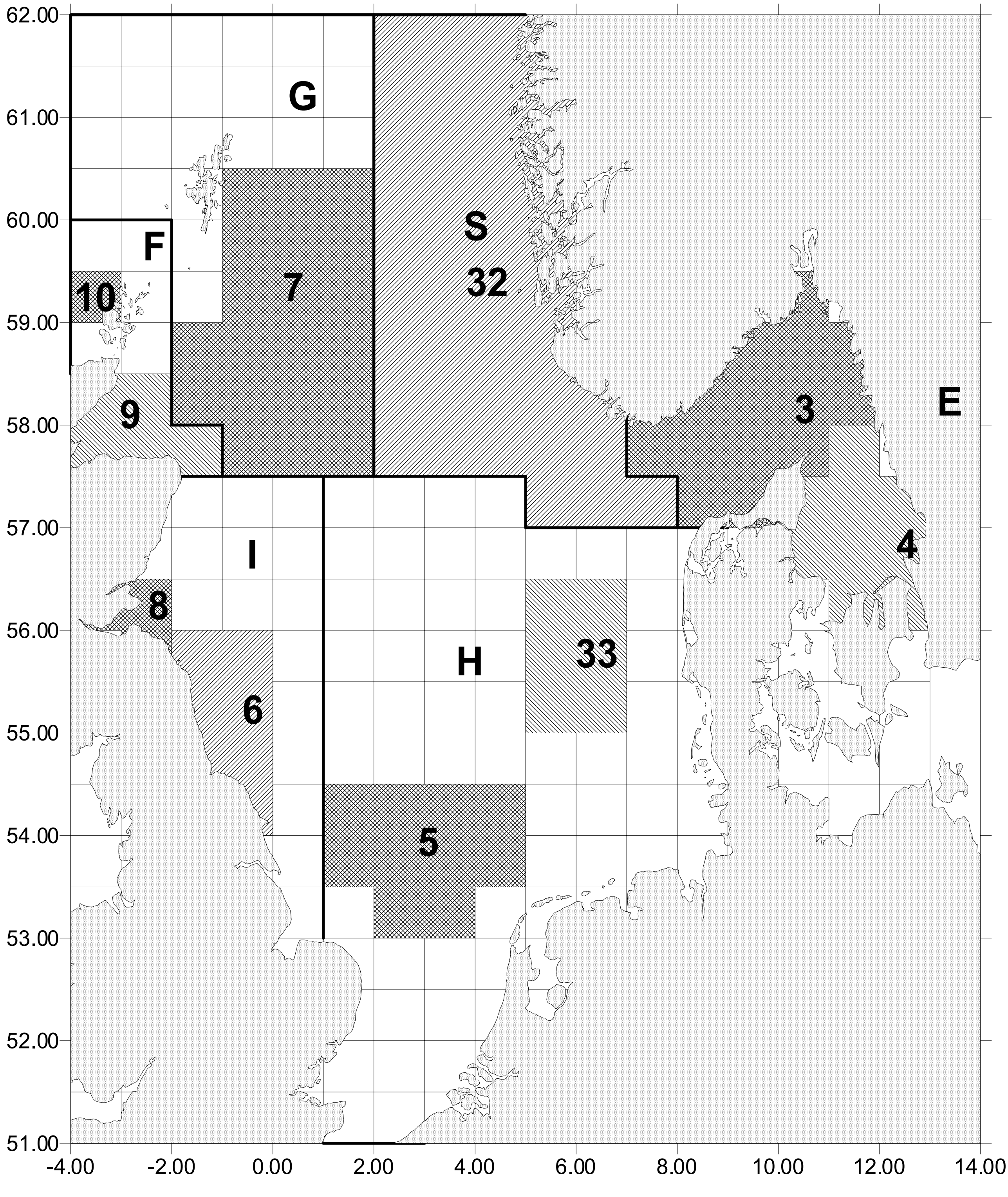


Figure 3.15.1.1 *Nephrops* Functional Units and Management Areas in Division IIIa and Subarea IV (letters and figures refer to Management Areas and Functional Units given in Table 3.14.1.1).

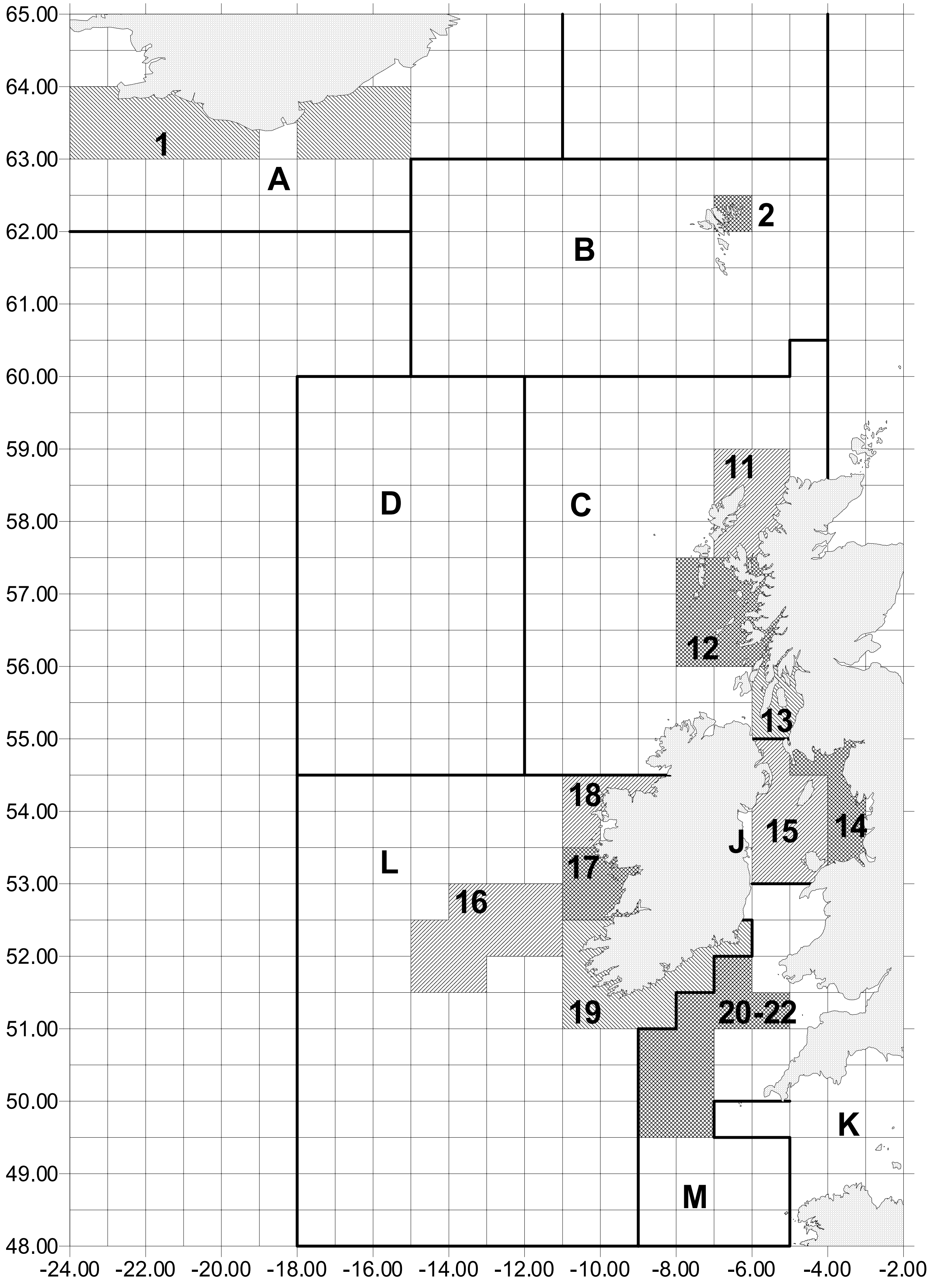


Figure 3.15.1.2 *Nephrops* Functional Units and Management Areas in Subareas V, VI and VII (letters and figures refer to Management Areas and Functional Units given in Table 3.14.1.1).

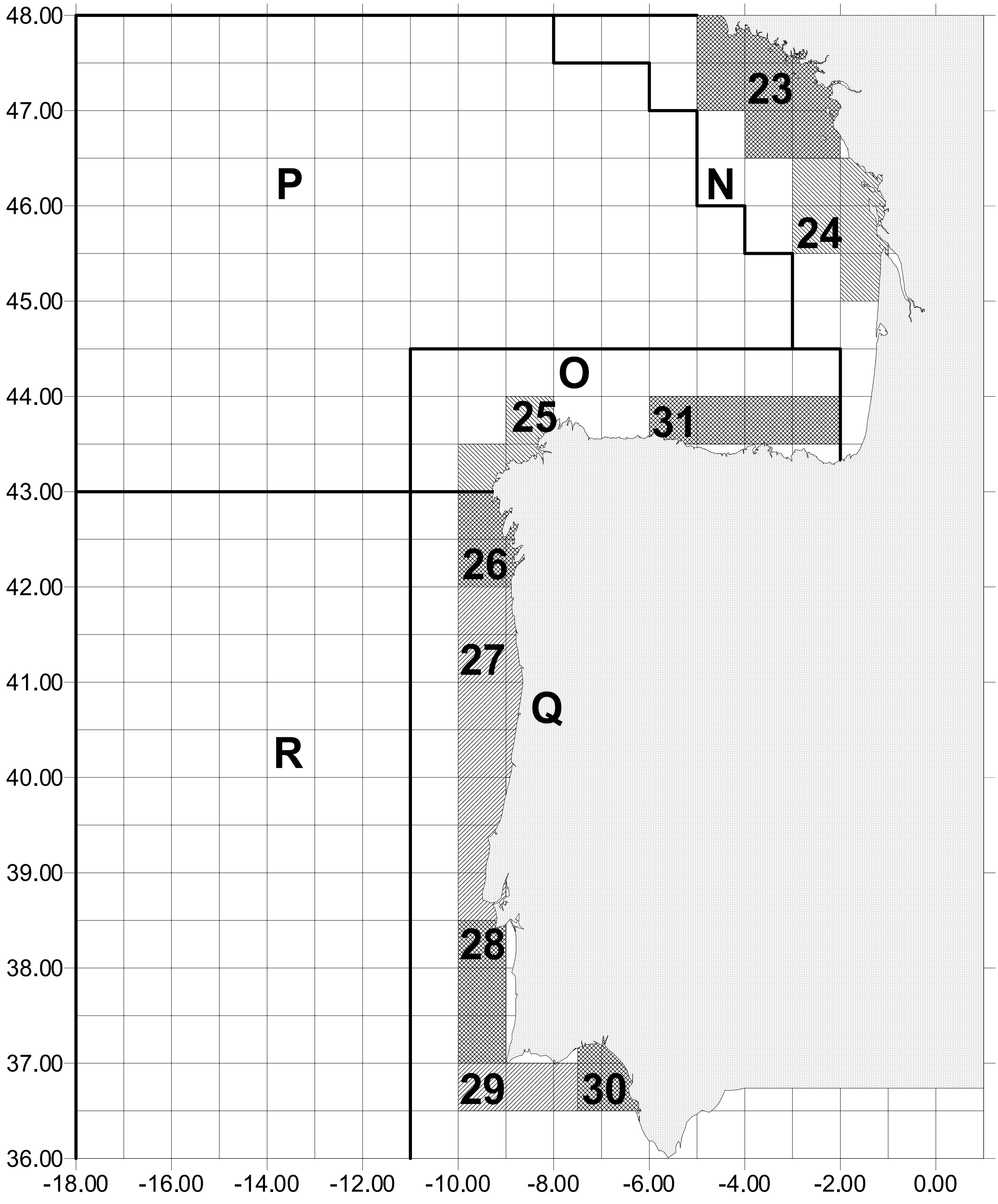


Figure 3.15.1.3 *Nephrops* Functional Units and Management Areas in Subareas VIII, IX and X (letters and figures refer to Management Areas and Functional Units given in Table 3.14.1.1).

3.15.2 *Nephrops* in Divisions VIIIa, b (Management Area N)

There are two Functional Units in this Management Area: a) Bay of Biscay North (FU 23) and b) Bay of Biscay South (FU 24), together called Bay of Biscay.

State of stock/exploitation: The stock biomass in this Management Area is at or near the lowest level of the series. This is attributed to the exploitation rate being too high and/or an inadequate fishing pattern causing high mortality of juveniles.

a+b) Annual LPUEs have been fairly stable, but with an upward trend since 1994 which is considered to indicate increased gear efficiency. Increased efficiency in recent years, even though not fully quantified, results from the use of twin trawls and rockhopper gear on single trawls. The latter and use of GPS has allowed exploitation of previously inaccessible areas. Age-based assessment indicates that biomass levels of males decreased in the late 1980s up to 1998. Despite a slight recovery in the last 3–4 years, male biomass remains at a low level. Female biomass has remained fairly stable from 1987 to 2001, but these estimates are considered to be less reliable than for males. Recruitment estimates show a trend of decline from the late 1980s up to the late 1990s. In males, there appears to have been some recovery since 1998. However, this is poorly estimated. In females, there has been a continuous trend of decline in recruitment up to 2001. $\mathbf{F}_{bar}$ has fluctuated without trend over the assessment time-series for both sexes. Y/R analysis based on outputs of VPA shows that current F is well above $\mathbf{F}_{max}$ for both males and females.

Management objectives: There are no management objectives set for this fishery.

Advice on management: In order to achieve a significant increase of the stock in the short term, ICES advises a 50% reduction in the exploitation rate. This corresponds to landings of 2200 t in 2003. Alternatively, a recovery plan could be implemented. Examples are presented below (see medium term projections).

Relevant factors to be considered in management: A mesh size increase was implemented in the year 2000, but there is no evidence that the exploitation pattern has been significantly improved. Simulations indicate that substantial increases in stock biomass could be achieved by improving the selection pattern. Any measure implying no catch of *Nephrops* at ages 1 and 2 (i.e., less than 26 mm CL) would bring about similar improvements in biomass in the medium term as a 30% reduction in F over all ages without any change in the exploitation pattern. It is worth noting that a difference of outcome between the two scenarios is that higher landings would be possible under the improved selection pattern.

The assessments, and consequently the short-term catch forecasts, are considered to be overoptimistic with respect to recent years, owing to the likely increase in effective effort. Increases in CPUE since 1994 are interpreted by the age-based assessments as increases in stock abundance and recruitment, whereas it is possible that they reflect (unquantified) increases in efficiency. Trial assessments tuned with a survey CPUE series only give a less optimistic picture of recent stock trends than when the commercial CPUE data are included as a tuning series. It is worth noting that there has been a deterioration in the quality of effort data since 1999. This results from a switch in the source of effort data from IFREMER fishing forms to the compulsory log books, for which there has been very low compliance.

Catch forecast for 2003: Catch options for FUs 23–24 (Bay of Biscay), males and females combined. $\mathbf{F}_{sq}$ for 2002 = $F_{1999\text{-}2001}$ (unscaled). Last column gives % change in SSB_{2004} vs SSB_{2002}.

F basis 2002	SSB 2002	Landings 2002	SSB 2003	F factor 2003	Landings 2003	SSB 2004	% change
F_{sq}	13080	3523	13628	0.0	0	20399	56
				0.2	952	18763	43
				0.4	1786	17321	32
				0.5	2165	16666	27
				0.6	2520	16050	23
				0.8	3165	14925	14
				1.0	3734	13927	6
				1.2	4236	13042	0
				1.4	4681	12253	-6
				1.6	5076	11549	-12
				1.8	5426	10921	-17
				2.0	5738	10359	-21

Medium-term projections: results for some scenarios are given below.

Year	Status quo F		50% reduction F		30% reduction F	
	SSB	Landings	SSB	Landings	SSB	Landings
2003	13333	3504	13333	2165	13333	2650
2004	13894	3699	16461	2669	15353	3220
2005	14261	3848	18957	3249	16800	3666
2006	14462	3929	20760	3668	17729	3951
2007	14574	3975	21983	3953	18297	4127

In the absence of any measure (*status quo* scenario), SSB and landings are predicted to remain stable around the lowest value of the time series. An immediate reduction of 50% of the fishing mortality is expected to increase SSB in 2004/2005 to the level of the early 90's. An immediate reduction of 30% of the fishing mortality would allow the same increase in SSB in 2007.

Comparison with previous assessment and advice: The results of this year's assessment confirm the assessments performed in 2001 and indicate that the Bay of Biscay *Nephrops* stock is at or near the lowest observed level during the assessed period. The stock biomass at the start of the series has been revised downwards in comparison with previous assessments.

Elaboration and special comment: Nearly all landings from FUs 23 and 24 are taken by French trawlers. Landings have been generally high, though fluctuating (typically between 4500 and 7000 t), until the early 1990s, but have decreased to a much lower level since then. Number of fishing days has decreased since 1994, owing to changes in fishing practices and decommissioning of vessels. Despite the decommissioning programme, it is likely that effective effort has been stabilised or even increased in recent years, owing to increased gear efficiency. The effort data used in the assessment do not take these efficiency gains into account, so that it is likely that there is some overestimation of recent abundance.

LPUE, mean sizes, and length compositions of the landings are available for the two FUs combined. Discard data are available for some years only. The VPA estimates of recruitment should be treated cautiously, owing to the lack of adequate discard data for most years in the timeseries.

Source of information: Report of the Working Group on *Nephrops* Stocks, 3 – 9 April 2002 (ICES CM 2002/ACFM:15).

Catch data (Tables 3.15.2.1–3.15.2.2)

Year	ICES advice	Recommended TAC	Agreed TAC	ACFM Landings
1987				5.7
1988				6.8
1989				5.4
1990				5.1
1991				4.8
1992		~6.8	6.8	5.7
1993		6.8	6.8	5.0
1994		6.8	6.8	4.1
1995		6.8	6.8	4.5
1996		6.8	6.8	4.3
1997		6.8	6.8	3.6
1998		4.2	5.5	3.3
1999		4.2	5.5	3.3
2000		4.2	4.44	3.3
2001		4.2	4.0	3.9
2002	*40 % reduction of current exploitation rate*	2.0	3.2	
2003	*50% reduction of current exploitation rate*	2.2		
2004				

(Weights in '000 t).

Table 3.15.2.1 *Nephrops* Landings (tonnes) by Functional Unit plus other rectangles in Management Area N (VIIIa,b).

Year	FU 23	FU 24	FUs 23-24 **	Other	Total
1992	5123	558	0	47	***5728***
1993	4404	512	0	49	***4965***
1994	3687	368	0	27	***4082***
1995	4060	379	0	14	***4453***
1996	4205	88	0	15	***4308***
1997	3451	147	2	43	***3643***
1998	2899	244	2	121	***3266***
1999	2872	337	2	127	***3338***
2000	2956	229	0	101	***3286***
2001*	3470	313	0	77	***3860***

* provisional
** countries reporting only aggregated landings for FUs 23-24

Table 3.15.2.2 *Nephrops* landings (tonnes) by country in Management Area N (VIIIa,b).

Year	Belgium	France	Spain	Total
1992	0	5681	47	***5728***
1993	0	4916	49	***4965***
1994	0	4055	27	***4082***
1995	0	4439	14	***4453***
1996	0	4293	15	***4308***
1997	2	3600	41	***3643***
1998	2	3224	40	***3266***
1999	2	3310	26	***3338***
2000	0	3250	36	***3286***
2001*	0	3838	22	***3860***

* provisional

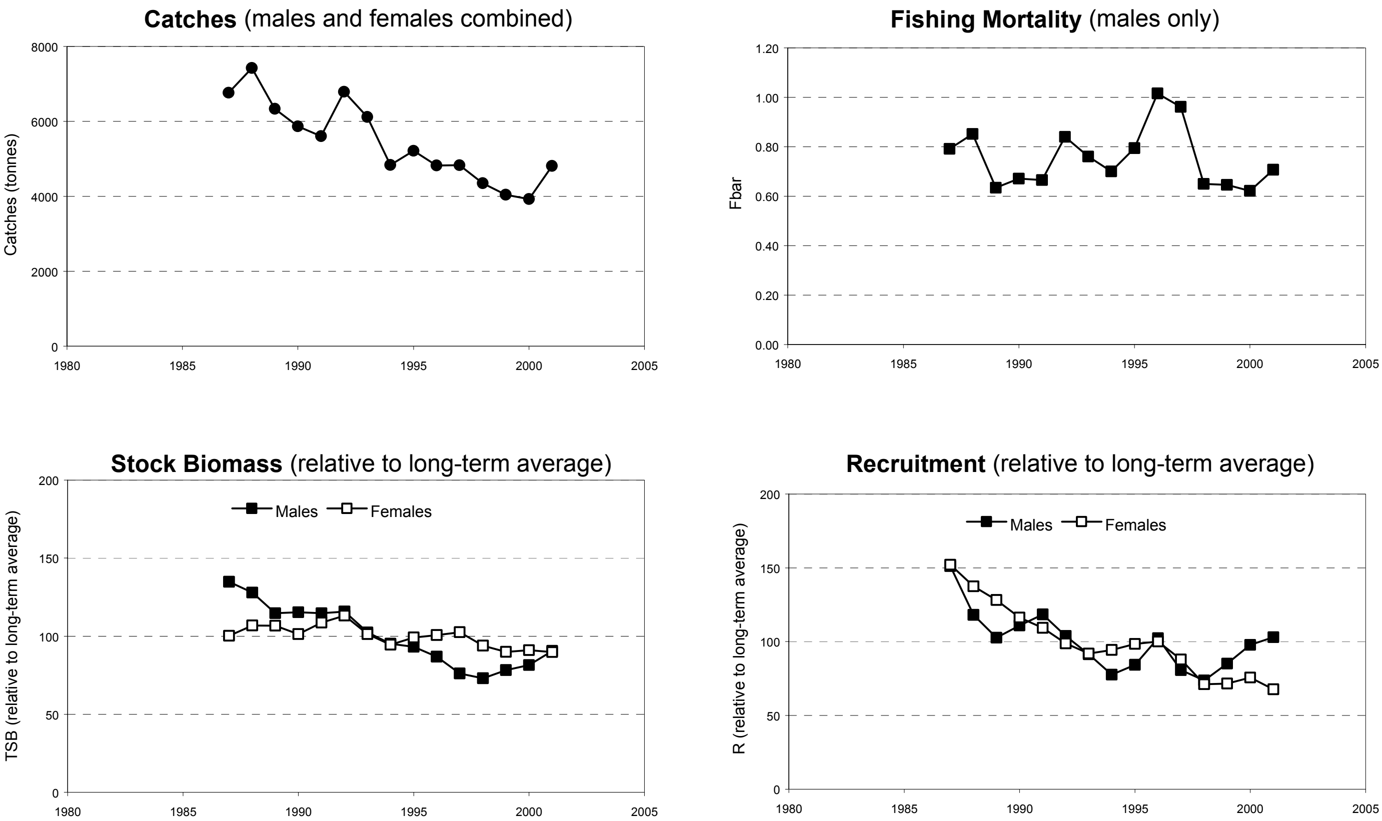


Figure 3.15.2.1 Bay of Biscay (FUs 23–24): VPA output: trends in catches, $\mathbf{F}_{bar}$, stock biomass, and recruitment.

3.15.3 *Nephrops* in Division VIIIc (Management Area O)

There are two Functional Units in this Management Area: a) North Galicia (FU 25) and b) Cantabrian Sea (FU 31).

State of stock/exploitation: All stocks in this Management Area are seriously over-exploited.

a) North Galicia: Annual LPUEs and landings fluctuate along a marked downward trend. A slight increase in landings in 2001 was due to landings in the fourth quarter of the year. Age-based assessment gives evidence of sharp declines in stock biomass and recruitment for both males and females. Current levels of stock biomass and recruitment are about 70% lower than in the late 1980s. $\mathbf{F}_{bar}$ values for males and females are fluctuating. Bottom trawl survey indices of abundance confirm the overall picture of a declining stock.

b) Cantabrian Sea: LPUEs are strongly fluctuating, with high values in 1988-90 and 1997-98, and much lower values in the other years. LPUEs for both Santander and Avilés fleets were at very low values in 1999-2001 compared to previous years. Mean landed sizes of both males and females were higher in 1999-2001 than in any previous year in the assessment series. Age-based assessments give evidence of drastic declines in recruitment and biomass of both males and females, at least since the early 1990s. Combined recruitment has fallen by almost 90% over this period, and stock biomass by almost 60%. $\mathbf{F}_{bar}$ values are fluctuating, but estimates for both males and females have declined since the mid-1990s, in line with effort. Bottom trawl survey indices of abundance also suggest a decline in the stock.

Management objectives: There are no management objectives set for this fishery.

Advice on management: ICES repeats its advice that fishing mortality on these stocks should be reduced to zero. If the by-catch of *Nephrops* in fisheries targeting other species makes this impossible, ICES recommends that suitable technical measures (closed areas, closed seasons, etc.) be investigated for implementation at the earliest possible opportunity in order to help rebuild the stocks.

Relevant factors to be considered in management: The mixed nature of the demersal fisheries in this Management Area has meant that historically the management measures for the target fish species have defined the levels of exploitation of *Nephrops*. This has prevented directed management of the *Nephrops* stocks in the area. However, to prevent further declines of the *Nephrops* stocks in Division VIIIc, fishing pressure on *Nephrops* must be substantially reduced. It is worth noticing that the agreed *Nephrops* TAC for Division VIIIc has never been restrictive.

F levels are higher in males than in females. There is no information on limiting sex ratios in *Nephrops*, but in principle the fertilisation success of females could be compromised by lack of mating opportunities at low stock densities.

Catch forecast for 2003: Pooled catch options for FU 25 (North Galicia) and FU 31 (Cantabrian Sea), males and females combined. FU 25: $\mathbf{F}_{sq} = F_{1999\text{-}2001}$, unscaled. FU 31: $\mathbf{F}_{sq} = F_{1999\text{-}2001}$, scaled to 2001. Last column gives % change in SSB_{2004} vs SSB_{2002}.

F basis 2002	SSB 2002	Landings 2002	SSB 2003	F factor 2003	Landings 2003	SSB 2004	% change
$\mathbf{F}_{sq}$	909	144	900	0.0	0	1061	17
				0.2	33	1022	12
				0.4	64	986	8
				0.6	93	952	5
				0.8	119	922	1
				1.0	143	893	-2
				1.2	167	865	-5
				1.4	188	841	-7
				1.6	209	819	-10
				1.8	227	797	-12
				2.0	244	776	-15

Comparison with previous assessment and advice: The assessment results from this year confirm those from last year and corroborate conclusions drawn previously from fishery statistics. All these sources of information point to severe overexploitation of stocks in Management Area O.

Elaboration and special comments: All catches from these FUs are taken by Spain. Landings and effort in both FUs have declined and are now at extremely low levels compared to earlier years.

LPUE and mean size data are available for both FUs. Length-frequency data has been available for FU 25 since 1986 and for FU 31 since 1989. Discarding in these fisheries is marginal. Abundance indices are available for both FUs, derived from bottom trawl surveys to estimate hake recruitment and to collect information on the relative abundance of demersal species in general.

Source of information: Report of the Working Group on *Nephrops* Stocks, 3 – 9 April 2002 (ICES CM 2002/ACFM:15).

Catch data (Tables 3.15.3.1–3.15.3.2):

Year	ICES advice	Recommended TAC	Agreed TAC	ACFM Landings
1987				0.53
1988				0.60
1989				0.52
1990				0.46
1991				0.56
1992		0.51	0.8	0.52
1993		0.51	1.0	0.37
1994		0.51	1.0	0.39
1995		0.51	1.0	0.37
1996		0.51	1.0	0.34
1997		0.51	1.0	0.32
1998		0.51	1.0	0.18
1999		0.51	1.0	0.17
2000		0.51	0.8	0.12
2001		0.51	0.72	0.17
2002	*Reduce catches to zero*	0	0.36	
2003	*Reduce catches to zero*	0		

Weights in '000 t.

Table 3.15.3.1 *Nephrops* landings (tonnes) by Functional Unit plus Other rectangles in Management Area O (VIIIc).

Year	FU 25	FU 31	Other	Total
1992	428	94	0	***522***
1993	274	91	0	***365***
1994	245	148	0	***393***
1995	273	94	0	***367***
1996	209	129	0	***338***
1997	219	98	0	***317***
1998	103	72	0	***175***
1999	124	48	0	***172***
2000	81	34	0	***115***
2001 *	147	26	0	***173***

* provisional

Table 3.15.3.2 *Nephrops* landings (tonnes) by country in Management Area O (VIIIc).

Year	Spain	Total
1992	522	***522***
1993	365	***365***
1994	393	***393***
1995	367	***367***
1996	338	***338***
1997	317	***317***
1998	175	***175***
1999	172	***172***
2000	115	***115***
2001*	173	***173***

* provisional

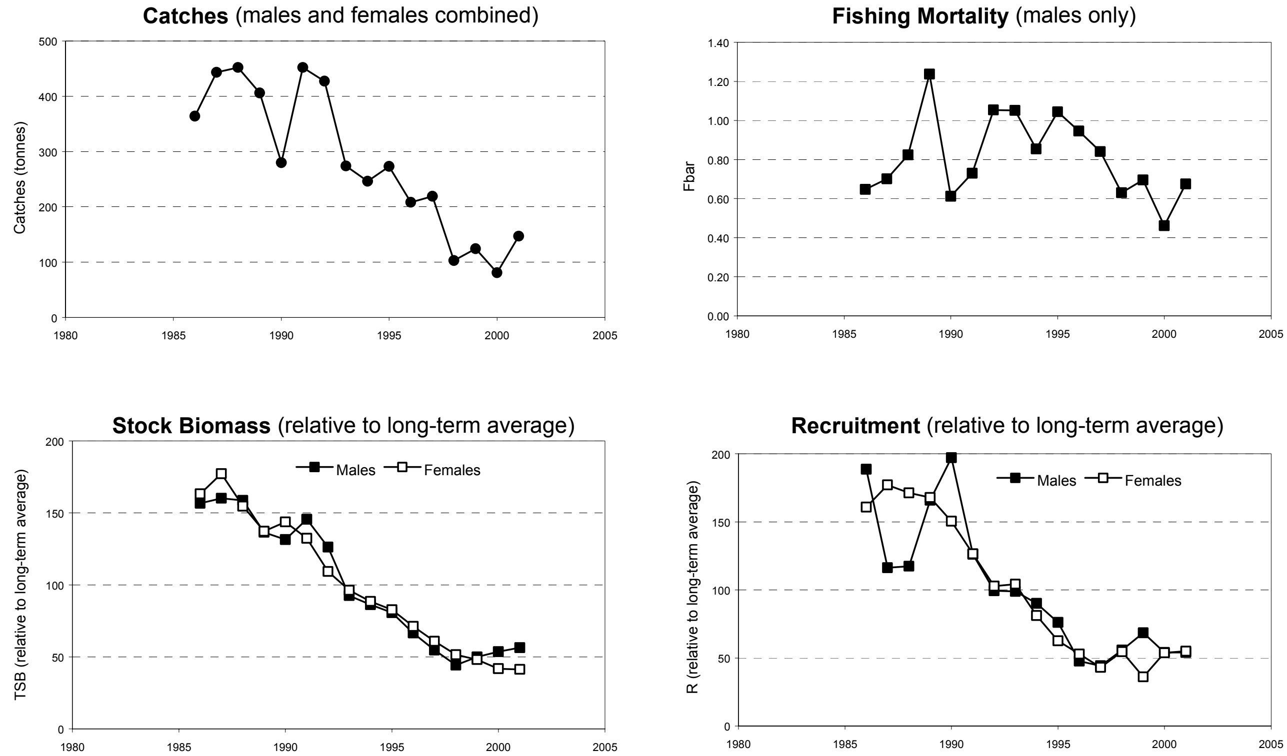


Figure 3.15.3.1 North Galicia (FU 25): VPA output: trends in catches, $\mathbf{F}_{bar}$, stock biomass, and recruitment. Recruitment values for males in 2000 and 2001 are the GM of the VPA estimates for 1996-99. Recruitment value for females in 2001 is the GM of the VPA estimates for 1994-2000. Stock biomass estimates in 2000 and 2001 are adjusted accordingly.

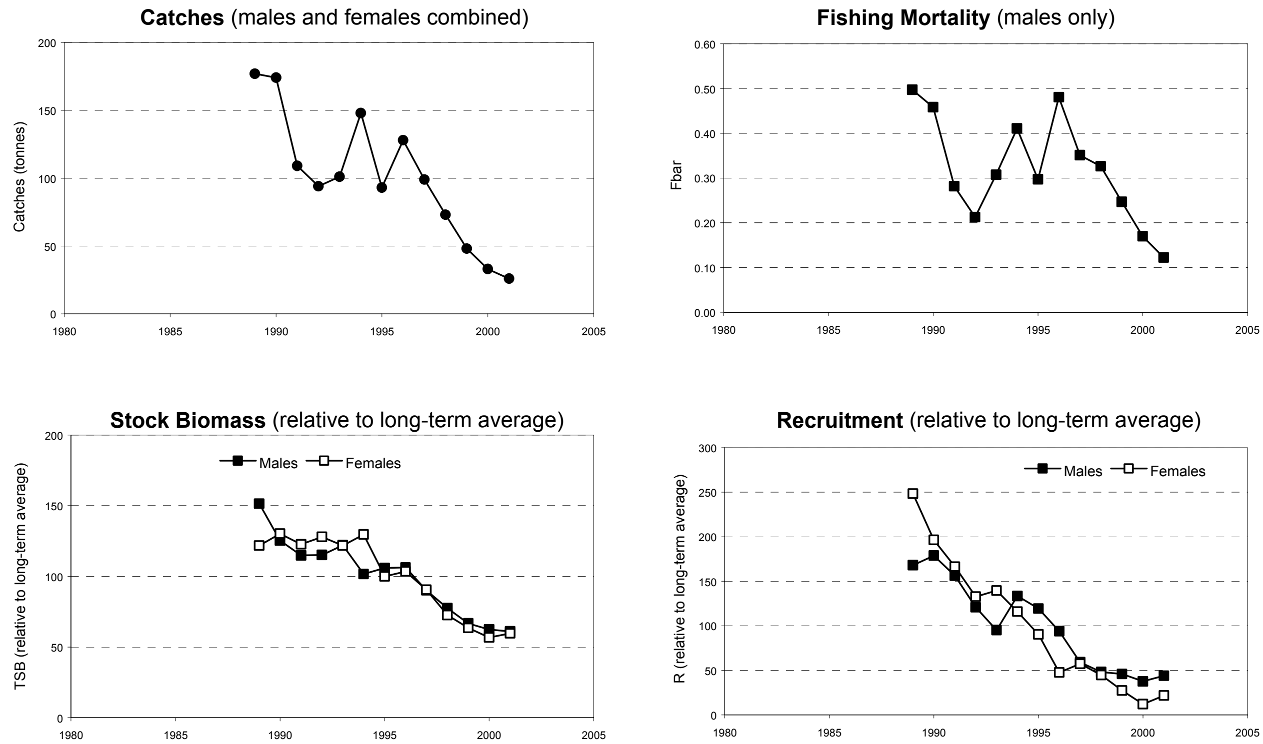


Figure 3.15.3.2 Cantabrian Sea (FU 31): VPA output: trends in catches, $\mathbf{F}_{bar}$, stock biomass, and recruitment. Recruitment value for males in 2001 is the GM of the VPA estimates for 1998-2000. Male stock biomass in 2001 is adjusted accordingly.

3.15.4 *Nephrops* in Division IXa (Management Area Q)

There are five Functional Units in this Management Area: a) West Galicia (FU 26), b) North Portugal (FU 27), c) Southwest Portugal (FU 28), d) South Portugal (FU 29), and e) Gulf of Cádiz (FU 30).

State of stocks/exploitation: All stocks in this Management Area are seriously over-exploited.

a+b) West Galicia and North Portugal: LPUEs for FU 26 are declining from relatively high levels for two ports and declining from already low levels for two other ports. The mean landed sizes of both males and females fluctuate widely, but are declining from relatively large sizes over the last two years. Age-based assessment for the two FUs combined gives evidence of sharp declines in stock biomass and recruitment in both males and females. Recruitment estimates for 2000 and 2001 need confirmation from later assessments and are discounted for the purposes of stock projection. Up to 1999, combined recruitment had fallen by 80% compared with the late 1980s, and stock biomass had fallen by 70%. $\mathbf{F}_{bar}$ is fluctuating without a long-term trend. Bottom trawl survey indices of abundance confirm the picture of a declining stock.

c+d) SW and S Portugal: Annualised CPUEs for Portuguese trawlers sharply declined in 1989–96, but have remained relatively stable since then. The age-based assessment indicates that stock biomass and recruitment of both males and females have sharply declined during the early 1990s, remaining at a very low level since the mid-1990s in males and continuing to decline in females. $\mathbf{F}_{bar}$ for males was high in the early 1990s, then decreased till 1997, but increased again to an even higher level in 2001. $\mathbf{F}_{bar}$ for females is fluctuating, without evidence of a long-term trend. The results of crustacean directed trawl surveys, usually carried out in June-August, support the perception of a declining stock.

e) Gulf of Cádiz: Limited data only are available for this FU. There is an overall trend of decrease in landings, with a decline from a peak in 1987 to a record low in 1996. Landings have increased somewhat in recent years and were almost doubled in 2001 compared to 2000. There are insufficient data to allow length- or age-based assessments.

Management objectives: There are no management objectives set for this fishery.

Advice on management: For FUs 26+27, ICES again advises a zero TAC in order to allow the stock to rebuild from the current low biomass levels. ICES also advises a zero TAC for FUs 28+29, in order to halt the deterioration of the stock. In both areas, however, this may not be possible, because of the mixed nature of the fisheries. Therefore, ICES recommends that suitable technical measures (closed areas, closed seasons, etc.) be investigated for implementation at the earliest possible opportunity in order to help rebuild the stocks.

For FU 30, ICES recommends that in order to constrain the effort landings are kept at the low level of the most recent years, i.e., 50 t.

Relevant factors to be considered in management: ICES notes that TACs agreed for recent years have been far in excess of ICES advice and achievable landings levels, even after the reduction in TAC from 1200 t in 2001 to 800 t in 2002. This is despite the strong signs that the further depletion of the stocks in this area can only be stopped by substantial reductions in fishing mortality.

F levels are higher in males than females. There is no information on limiting sex ratios in *Nephrops*, but in principle the fertilisation success of females could be compromised by lack of mating opportunities at low stock densities.

Catch options:

1. Catch option for FUs 26+27 (West Galicia and North Portugal), males and females combined. $\mathbf{F}_{sq} = F_{1999\text{-}2001}$ scaled to F_{2001}. Last column gives % change in SSB_{2004} vs. SSB_{2002}. Note that the stock projections were conservative with respect to recruitment in 2000.

F basis 2002	SSB 2002	Landings 2002	SSB 2003	F factor 2003	Landings 2003	SSB 2004	% change
F_{sq}	463	105	501	0.0	0	677	46
				0.2	28	641	38
				0.4	54	608	31
				0.6	77	579	25
				0.8	99	551	19
				1.0	118	525	13
				1.2	137	502	8
				1.4	153	481	4
				1.6	169	462	0
				1.8	183	445	-4
				2.0	196	427	-8

2. Catch option for FUs 28+29 (SW and S Portugal), males and females combined. $\mathbf{F}_{sq} = F_{1999\text{-}2001}$, scaled to F_{2001} in males, unscaled in females. Last column gives % change in SSB_{2004} vs SSB_{2002}.

F basis 2002	SSB 2002	Landings 2002	SSB 2003	F factor 2003	Landings 2003	SSB 2004	% change
F_{sq}	486	163	389	0.0	0	479	-1
				0.2	29	446	-8
				0.4	55	415	-15
				0.6	79	389	-20
				0.8	99	365	-25
				1.0	117	344	-29
				1.2	134	325	-33
				1.4	150	308	-37
				1.6	163	293	-40
				1.8	176	279	-43
				2.0	187	266	-45

Comparison with previous assessment and advice: Previous age-based assessments of the West Galicia and North Portugal stocks (FUs 26+27) and of the SW and S Portugal stocks (FUs 28+29) indicated strong declines in biomass and recruitment in both cases. This year's advice for FU 28+29 differs from the one provided last year, due to a further decline in recruitment and downward revision of forecasted recruitment. As a result now, to stop further stock decline, no fishery should be allowed, while in last year's assessment the same goal could be achieved with a 40% reduction in fishing mortality.

Elaboration and special comments: The fishery in FUs 26, 27, and 30 is mainly conducted by Spain, and that in FUs 28 and 29 by Portugal, on deep-water grounds (200–750 m). The Portuguese fleet comprises two components: demersal fish trawlers and crustacean trawlers. Landings from all FUs within this Management

Area have declined significantly in recent years. Effort in FUs 26 and 27 in general is declining. In FUs 28 and 29, effort fell in the late 1980s, and has since remained at a low level despite a slight increase from 1999 to 2001.

The advice for Management Area Q given by ICES in 2001 incorporated a 40% reduction in F in FUs 28–29 in order to halt the deterioration of the stock. Stock projections based on this year's assessments indicate that if the same advice was followed in 2003 the stock biomass would continue to decline. Only zero catches will achieve the end of halting the current trend of decline.

CPUEs and/or LPUEs, effort data, and mean size data are available for most FUs, except FU 30 (Gulf of Cádiz). Length-composition data are available for FUs 26+27 combined and for FUs 28+29 combined. Discarding is marginal in these fisheries. Research trawl survey data are available for FU 26 and for FUs 28+29. Mean sizes of both males and females in landings and trawl survey catches show weak overall trends of increase in FUs 28+29.

Age-based assessments indicate a possible recovery of recruitment of both males and females in FUs 26+27 in 2000. This will need to be confirmed by subsequent assessments before it can be accepted as a real feature of the stock. The 2000 recruitment estimates were discounted for the purposes of stock projection.

Source of information: Report of the Working Group on *Nephrops* Stocks, 3 – 9 April 2002 (ICES CM 2002/ACFM:15).

Catch data (Tables 3.15.4.1–3.15.4.2):

Year	ICES advice	Recommended TAC	Agreed TAC	ACFM Landings
1987				1.55
1988				1.29
1989				1.35
1990				1.19
1991				1.31
1992		1.3	2.5	1.35
1993		1.3	2.5	1.06
1994		1.3	2.5	0.79
1995		1.3	2.5	0.92
1996		1.3	2.5	0.51
1997		1.3	2.5	0.67
1998		0.5	2.5	0.60
1999		0.5	2.0	0.58
2000		0.5	1.5	0.43
2001		0.5	1.2	0.58
2002		0.17	0.8	
2003		0.05		

Weights in '000 t.

Table 3.15.4.1 *Nephrops* landings (tonnes) by Functional Unit plus Other rectangles in Management Area Q (IXa).

Year	FU 26 **	FU 27 **	FU 26-27 **	FU 28-29	FU 30	Other	Total
1992	199	52	385	470	243	0	***1349***
1993	162	50	310	377	160	0	***1059***
1994	120	22	306	237	107	0	***792***
1995	117	10	384	273	132	0	***916***
1996	264	67		132	49	0	***512***
1997	359	74		136	99	0	***668***
1998	295	50		161	89	0	***595***
1999	194	54		211	123	0	***581***
2000	102	30		201	92	0	***425***
2001*	105	27		271	178	0	***582***

* provisional
** disaggregated data by FU not available for all countries in all years

Table 3.15.4.2 *Nephrops* landings (tonnes) by country in Management Area Q (IXa).

Year	Portugal	Spain	Total
1992	522	827	***1349***
1993	427	632	***1059***
1994	259	533	***792***
1995	283	633	***916***
1996	149	363	***512***
1997	142	526	***668***
1998	169	426	***595***
1999	216	365	***581***
2000	210	215	***425***
2001*	278	304	***582***

* provisional

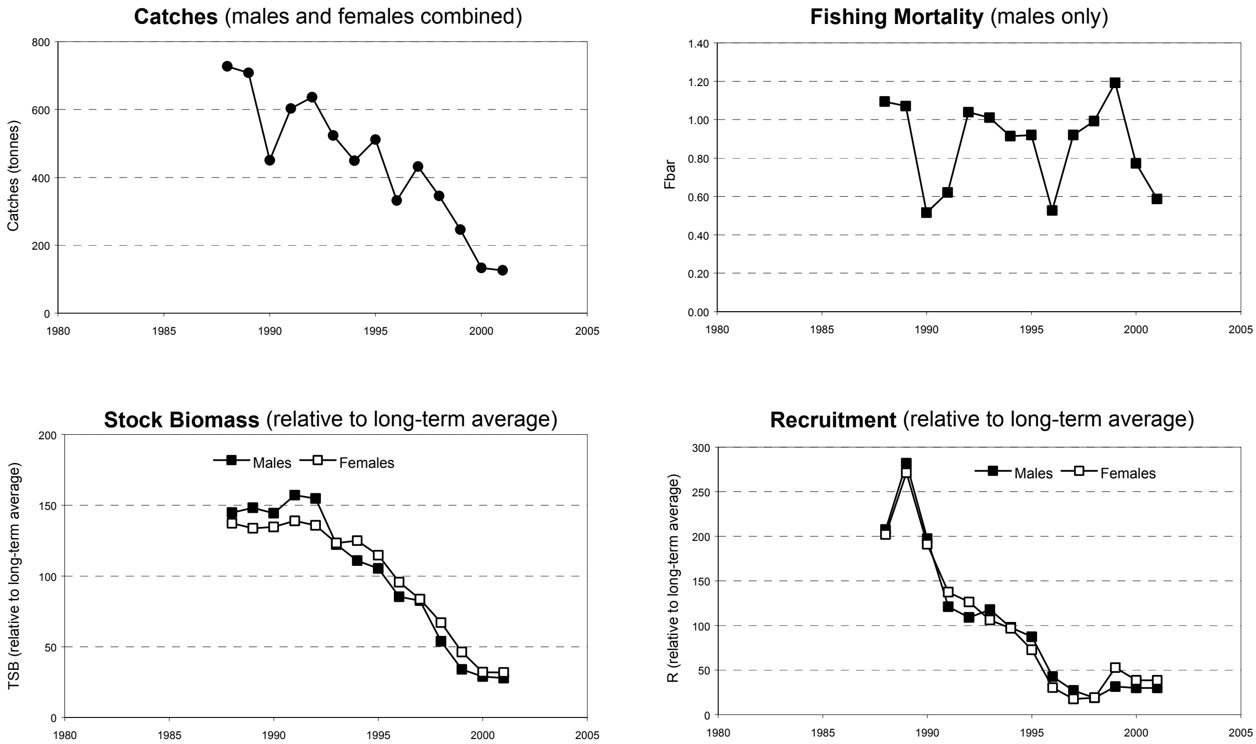


Figure 3.15.4.1 West Galicia and North Portugal (FUs 26–27): VPA output: trends in catches, $\mathbf{F}_{bar}$, stock biomass, and recruitment. Recruitment values for 2000 and 2001 are the GM of the VPA estimates for 1996–99. Stock biomass estimates for 2000 and 2001 are adjusted accordingly.

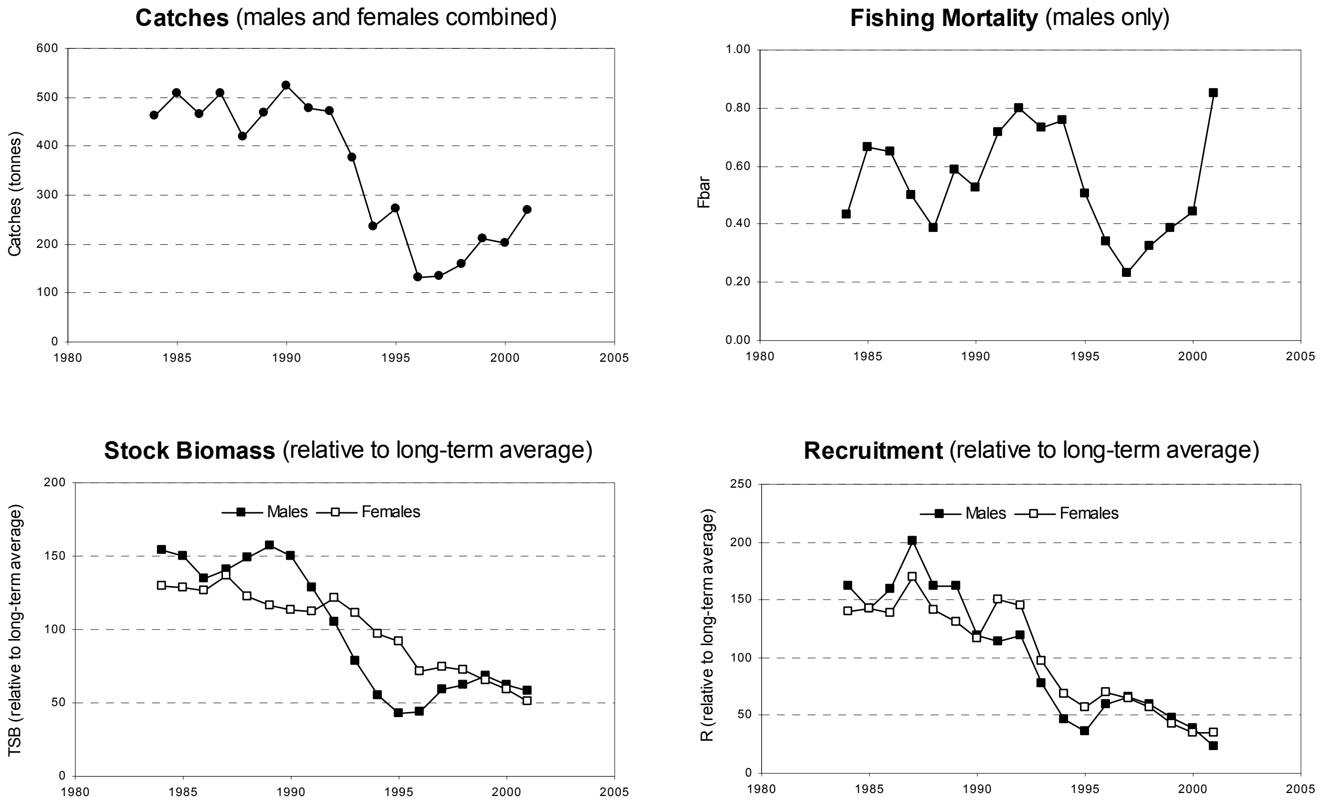


Figure 3.15.4.2 SW and S Portugal (FUs 28–29): VPA output: trends in catches, $\mathbf{F}_{bar}$, stock biomass, and recruitment.

4 ATLANTIC SALMON IN THE NORTH ATLANTIC AREA

4.1 Catches of North Atlantic Salmon

4.1.1 Nominal catches of salmon

Nominal catches of salmon reported by country in the North Atlantic for 1960–2001 are given in Table 4.1.1.1. Catch statistics in the North Atlantic also include fish farm escapees and, in some northeast Atlantic countries, ranched fish.

Reported catches (in tonnes), in four North Atlantic regions are illustrated in Figure 4.1.1.1, and those for NASCO Commission Areas, 1994–1998 are shown below.

Area	1994	1995	1996	1997	1998	1999	2000	2001
NEAC	3586	3282	2753	2075	2226	2072	2728	2887
NAC	258	261	294	231	159	154	155	147
WGC		90	92	59	17	19	29	43
Total		3628	3138	2365	2397	2245	2905	3078

The catch data for 2001 (Table 4.1.1.1) are provisional, but the total nominal catch of 3 078 t is amongst the lowest on record. However, catches in several countries were above the 5 year and 10 year averages.

The nominal catch (in tonnes) of wild fish in 2001 was partitioned according to whether the catch was taken by coastal, estuarine or riverine fisheries. These are shown below for the NEAC and NAC Commission Areas. It was not possible to split the Danish catch in 2001 and this has been excluded from the calculation. The proportions accounted for by each fishery varied considerably between countries. In total, however, coastal fisheries accounted for 54% of catches in North East Atlantic countries compared to 10% in North America, whereas in-river fisheries took 40% of catches in North East Atlantic countries compared to 76% in North America.

Area	**Coast Weight**	**%**	**Estuary Weight**	**%**	**River Weight**	**%**	**Total Weight**
NEAC	1557	54	177	6	1147	40	2880
NAC	15	10	20	14	112	76	147

4.1.2 Catch and release

Catch and release data for the 1990s have been provided by 6 countries. In 2001, the proportion of the total rod catch that was released ranged from 76% in Russia to 12% in Iceland. Other catch and release rates were 55%, 43% and 39% for Canada, UK (England & Wales) and UK (Scotland), respectively. In most of these countries, rates in 2001 are among the highest in each time series and indicate an increasing trend in recent years.

4.1.3 Unreported catches of salmon

The total estimate of unreported catch within the NASCO Commission Areas in 2001 was 1 170 t (Table 4.1.1.1), or 27.5 % of the total of reported and unreported catch. There has been a decrease in the level of unreporting over the last 4 years. After 1994 there are no data available on salmon catches in international waters. Limited surveillance flights, which were the basis of past estimates of catches in international waters, have not reported any salmon fishing where these have occurred in recent years. Estimates (in tonnes) of unreported catches for the Commission Areas are given below:

Area	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
NEAC	1157	942	947	732	1108	887	1135	1079
NAC	107	98	156	90	91	133	124	81
WGC	<12	<20	<20	5	11	12	< 10	<10
Interntl. waters	25–100	n/a	n/a	n/a	n/a	n/a	n/a	n/a

The national inputs to the total North Atlantic catch range from 0% to 16%. While this broadly indicates the level of non-reporting by each country relative to the total catch in the North Atlantic, it should be noted that methods of estimation vary both within and among countries. The non-reporting rates range from 0% to 65% of the total national catch in each country.

Unreported catches are included in subsequent assessments and catch advice.

4.1.4 Production of farmed and ranched salmon

The production of farmed Atlantic salmon in the North Atlantic area was 704,177 t in 2001, an increase in production over 2000 (658,952 t). The 2001 production was 27% higher than the 1996–2000 average (554,284 t) for the area. The countries with the largest production were Norway and Scotland, accounting for 61% and 23% of the reported North Atlantic total. Reported increases compared to average production for 1996 to 2000 ranged from 77% for the Faroes to 4% for Iceland and USA.

The worldwide production of farmed Atlantic salmon in 2001 was 961,120 t, an increase compared to 891,528 t in 2000 (Figure 4.14.1). Outwith the North Atlantic area, Chile was the major producing country. The worldwide production of farmed Atlantic salmon compiled for 2001 was approximately 310 times the reported nominal catch of Atlantic salmon in the North Atlantic. As a result, aquaculture fish dominate world markets, and have probably contributed to the decline in commercial fishing effort in many countries.

Catches of ranched salmon have declined substantial from a high of 500 t in 1993 to less than 20t in 2001 (Figure 4.1.4.2) due to the closure of the Icelandic salmon ranching industry in 1999.

4.2 Review of the estimation of natural mortality (M)

4.2.1 Methods for and estimates of natural mortality (M) at sea

ICES has used an instantaneous rate of natural mortality of 0.01 per month in the NEAC and NAC models to estimate PFA of salmon. The assumed rate is from an analysis of catch-at-age and weight-at-age data from the River Bush (U.K.) and the Sandhill River (Canada) as developed by Doubleday *et al.* (1979). This rate of natural mortality has been used to calculate the number of fish immediately after the first winter, prior to the high seas fisheries, and between the high seas fisheries and returns to homewaters.

ICES reviewed theoretical and empirical methods for estimating M for Atlantic salmon. Theoretical methods are those based on life history characteristics such as lifetime fecundity, maximum age, age at maturity, and inverse-weight. Empirical methods are those based on actual measures of smolts and adult abundance at different life stages and two of these, the inverse-weight method and the maturity schedule method were applied to historical and recent data for stocks from the North Atlantic.

<u>Inverse Weight Method</u>

Ricker (1976) described a method for estimating the natural mortality rate based on the assumption that M decreases with increased size because marine natural mortality is assumed to be primarily the result of predation. When considered across phyla (from pelagic invertebrates to whales; McGurk 1986), there is a negative association between mortality rate and body weight (dry weight) with the exponent in the order of –0.25 (McGurk 1986).

Preliminary estimates of M for Atlantic salmon during the second year at sea were presented by Doubleday *et al*. (1979). Using three years of two smolt group releases from the River Bush, Doubleday *et al*. (1979) demonstrated that there was a significant negative association between integrated marine survival for the cohorts and initial marine mortality determined by smolt size.

Using the exponential growth model, the monthly mortality rates for River Bush fish in the second year at sea (days 516 to 834) ranged between 0.1% and 0.3% per month with survival of age-1 smolts less than that of age-2 smolts (Table 4.2.1.1). For the Sandhill River salmon, mortality rates in the second year at sea (months 14 to 24) ranged between 1.2% and 1.5% per month. Growth rates of Sandhill River fish were lower than those of River Bush and hence the mortality rates on Sandhill River fish were higher (Figure 4.2.1.1).

The exponential growth functions were considered to be less satisfactory representations of the weight at age of salmon at sea than linear growth models (Figure 4.2.1.1). For both stocks, weight at age of 1SW salmon was underestimated while that of 2SW salmon was overestimated (excessively so for River Bush). Simpler linear growth models were adjusted to the data from River Bush and North America. When these models were applied to the life stage recovery data, the mortality rate estimates in the second year at sea increased slightly to between 1.4% and 1.7% for the Sandhill River salmon. There was a greater increase for the River Bush fish, to between 0.8% and 1.8% (Table 4.2.1.1) resulting from the lower weight at age predicted for the older fish (Figure 4.2.1.1).

Including new data from the River Bush shows that weights at age have not changed from historical values and again the linear growth curve provides a more satisfactory fit to the data (Figure 4.2.1.2). Data for sixteen years from the River Trinite (Quebec) are determined from mean weight at age back to the river and the time at sea determined from the mean date of return and of the age groups and the mean smolts date of migration of the corresponding smolts age group.

Again, the linear growth curve appears to be a better fit to the data (Figure 4.2.1.3) and this was used subsequently to derive estimates of "M" in the second year at sea. The inverse-weight model described by Doubleday *et al.* (1979) provides correct estimates of M (as determined by simulation) provided the assumption of the inverse-weight association is valid. The estimates of M are sensitive to the growth model used. The exponential models produce lower mortality rate estimates than the linear growth models but the linear models have provided a better fit to the observed weight at age data.

The inverse-weight model was applied to more recent observations from the River Bush as well as to growth and abundance data of the River Trinite, LaHave River and Northwest Miramichi River (Canada). For the River Bush, the monthly mortality rates in the second year at sea of the 1999 hatchery one-year old smolts were estimated at more than three times the values in the 1970s, at 1% to 2% per month using the exponential growth model and almost 3% per month with the linear growth model (Table 4.2.1.2). For the Canadian stocks, monthly mortality rates in the second year at sea for both hatchery smolts and wild smolts from River Trinite have risen above 3% in the 1990s. The mortality rates on two wild stocks of the Maritimes in the 1990s were estimated to be between 2.4% and 3.2%, well above the 1.5% value estimated for the Sandhill River salmon between 1969 and 1971. This suggests that there may have been an increase over time in the mortality rate during the second year however long-term data for individuals stocks are scarce.

Maturity Schedule Method

Ricker (1976) summarized a number of approaches which he termed "maturity schedule methods" to derive estimates of natural mortality at sea for stocks which mature at two or more different ages. A particular approach termed "Murphy's Method" (Ricker 1975) was used to estimate the ocean mortality of Icelandic ranched Atlantic salmon during the second year at sea (Jonasson *et al*. 1994). A variation of these methods, which allows estimates of survival during the first and second years at sea and which wasdescribed by Chaput *et al.* (2002), was reviewed in ICES CM 2001/ACFM 1). Additional results are given in Table 4.2.1.2.

The model proposed by Chaput *et al*. (2002) allows for the estimation of survival rates during the first and second years at sea based on return of 1SW and 2SW salmon and sex ratios of outmigrating smolts. The model makes some general assumptions:

- survival rates at age for males and females are similar, and
- survival rates in the first year at sea of maturing and non-maturing salmon are similar.

Comparison of Maturity Schedule and Inverse-Weight Estimates

Differences in the mortality rate estimates using the inverse-weight method compared to the maturity schedule method for some stocks and time periods are apparent (Tables 4.2.1.1 and 4.2.1.2). The estimates for the River Trinite during the 1990s were similar, at about 3% per month using the two estimation methods. The estimates were very different in the 1980s when marine coastal exploitation was still occurring on this stock. It would appear that the inverse-weight method was insensitive to the marine exploitation, being driven primarily by the growth function, however violations of the assumptions of the maturity schedule method could also have produced the divergent results. The maturity schedule values for LaHave River and Miramichi River, and the Saint John River hatchery smolts are much higher than the inverse-weight estimates for corresponding years, by up to five times.

Both the inverse weight and the maturity schedule models indicate that M in the second year of sea life is greater than 1% per month. Doubleday *et al.* (1979) used the exponential growth model to estimate the coefficients of the inverse-weight model, however, in most rivers examined the exponential model does not provide a good description of the marine growth function of Atlantic salmon, especially for months 12 to 24. A simple linear function fit the data more realistically than the exponential model. Based on this linear function of growth, the inverse-weight method produced monthly mortality rate estimates during the second year at sea which varied between 1% and 3.4% (range of median values) for stocks from the North Atlantic (Table 4.2.1.2). Over the entire time and stock series analysed, the inverse-weight models indicate an M of 0.03 per month in the second year at would be more appropriate than the previously assumed value of M = 0.01.

The maturity schedule method results suggest that for some stocks, mortality in the second year at sea may also be driven by size-independent factors. In contradiction to the inverse-weight method that assumes that size determines M, mortality in the second year at sea may also be modified by factors which are non-size selective, such as parasites, disease, temperatures, or even marine mammal predators which may not be constrained in their predation rates by the size range of salmon in the second year at sea. The differences in the estimated mortality rates determined by the two methods suggest further hypotheses should be examined to test the assumptions of the inverse-weight and maturity schedule methods and factors which are modulating marine mortality of salmon at all ages.

Based on the analyses reviewed, the inverse-weight method was used as the basis of estimating M because the maturity schedule method yielded values of M that varied temporally and spatially, and it was not clear whether it was appropriate to apply values from this method to all stocks and the entire time series. However, the most appropriate growth function for use with inverse-weight method was linear rather than the previously used exponential function. This change in growth function, plus analysis of data from additional rivers, resulted in the instantaneous monthly mortality rate previously used in the run-reconstruction model for the North American and NEAC areas to be changed from 0.01 to 0.03 for this years analyses and the provision of catch advice.

Despite the continued use of the inverse-weight method, the limitations of this method in assuming that mortality is driven entirely by size were noted, and further analyses is recommended to test assumptions of the inverse-weight and maturity schedule methods. Based on the results of these analyses, the two methods will continue to be examined for applicability in modelling.

4.2.2 Effects of higher values of M on PFA models, conservation limits and catch advice

As a result of the decision to change the value of M from 0.01 to 0.03 per month in the second year at sea, the effects of increasing M on estimates of pre-fishery abundance and conservation limits in the NASCO-NEAC area and the implications for management advice were reviewed.

The NEAC PFA and National CL models are presented in Section 5.3. Natural mortality enters into the estimation of PFA model at the stage when the numbers of salmon alive at the beginning of the second sea year are back-calculated from the estimated numbers of fish returning to homewaters. Increasing M from 0.01 to 0.015 per month increases the estimated PFA of maturing 1SW salmon by about 4% and of non-maturing salmon by 9% (Table 4.2.2.1). Increasing M to 0.05 per month will increase the estimated PFA values by 38% and 97% respectively. The substantial difference between maturing and non-maturing 1SW salmon is due to the different lengths of time between the beginning of the second sea year and the return of the fish to homewaters.

Although the PFA values are used in the estimation of the national CLs, a change in M does not affect the position of the inflection point, relative to the x-axis (lagged egg deposition) because all PFA values are increased by the same proportion (Figure 5.3.2). This would not be the case if different values of M were used for different time periods.

The potential effects of increasing M to 0.03 on catch advice is illustrated in Table 4.2.2.2 for Southern European MSW salmon stocks (at hypothetical levels). As indicated, both the PFA and the Spawner Escapement Reserve will be increased by the same percentage (40%), and as a result the estimated harvestable surplus will also be increased by this margin. If a fixed proportion of this surplus is allocated to an interception fishery, any quota will also be increased by the same percentage. However, the survivors from the fishery (assuming that the full quota is taken) will also be subject to the higher level on M and so there will be no change in the estimated numbers of fish returning to homewaters. A similar situation would occur for North American stocks but the relative changes in the SER and PFA would be different.

The consequences to the fishery of using inappropriate values of M differ from the consequences to the resource. If the assumed M is higher than the realized value, then the quota will be set too high and the stock will suffer. If M is underestimated, harvestable surplus may be foregone but the stock will receive more spawners. More importantly, if M is very much higher than currently assumed, the beneficial effects of reducing or closing distant water fisheries towards increasing spawning escapements will be overstated, which may have major implications for our understanding of the reasons for recent stock declines. Our understanding of salmon stock dynamics may be further at error if M has changed over time; this would affect both PFA and CL estimates. It is important to note that PFA is a 'latent variable' (a value which can never be measured directly) but it has value as a means to conceptualise the stock status and develop management advice. It will not be possible, in the short term, to directly validate the assumed values of M.

4.3 Recent Research Developments and Information

4.3.1 Incidence of infectious salmon anaemia virus in the USA

Information was presented to ICES about infectious salmon anaemia (ISA) in North America. Aggressive control measures taken in Canada resulted in only one site reporting the disease to date from the spring 2000 smolt class. No ISA was detected in wild and escaped-farmed fish entering the Magaguadavic River, where positive tests for both groups were obtained for the first time in 1999. Positive tests for ISA were recorded for the first time in 2000 from the Margaree River Nova Scotia, the Morell River in Prince Edward Island, and the Saint John River New Brunswick, however, the initial results are problematic because they could not be confirmed. The first confirmed case of ISA from the East Coast USA salmon farming industry was announced on 16 March 2001. The US industry is now implementing measures similar to those used in Norway, Scotland and Canada to manage the problem. Genomics research found that European ISA isolates (Scotland and Norway) were 98 – 100% similar, whereas the Canadian isolate was only about 84–88% similar to the European group. The strains may have diverged from each other about 1900, which corresponds to a period of transfers of salmonids from North America to Europe (Rainbow trout) and from Europe to North America (sea run brown trout). Both species are asymptomatic hosts of the virus. It is not known where the virus originated. Independent testing of a widely used vaccine confirmed a significantly increased survival rate for fish that had been vaccinated.

4.3.2 Escaped farmed salmon of European ancestry in a Canadian River

In Maine, European strains of salmon were legally imported for salmon farming, although the practice has now been stopped. By contrast, the use of European strains is prohibited in Canadian East Coast salmon farming, and at present New Brunswick's Department of Fisheries and Aquaculture only issues commercial culture permits for Saint John River stock. Restrictions on the use of foreign strains of salmon in fish farming are in place due to concerns that the unintended introgression of foreign genes into indigenous salmon populations could decrease the indigenous populations' fitness.

The Magaguadavic River is located near the geographic center of the Canadian East coast Atlantic salmon farming industry, and slightly North of the majority of Maine (USA) salmon farms. Fish entering the Magaguadavic River from the sea must pass through a fish ladder, where they can be enumerated and sampled. Fish counts here have been used since 1992 as an indicator of the potential number of wild and escaped-farmed salmon entering other rivers in the region. In addition, three commercial hatcheries producing about four million smolts per year are located in the watershed. Escaped juvenile smolts from these hatcheries have been documented in the river's smolt run in each year since monitoring began in 1998.

Tissue samples were obtained from Magaguadavic River adult wild salmon, Magaguadavic adult and juvenile (smolts) escaped-farmed salmon, European-origin farmed salmon broodstock, and adult wild salmon from other Bay of Fundy and Southern Uplands (Nova Scotia, Canada) rivers. They were used in a microsatellite tetranucleotide analysis to screen for escapees of European ancestry entering this Canadian river. Results of genetic screening showed that of 88 wild Magaguadavic fish (30 smolts, 58 adults), none had the European alleles. Nor did the 1500 and 1000 wild salmon tested from inner Bay of Fundy rivers or the Southern Uplands, respectively. By contrast, of the 88 farmed-escaped salmon analyzed (35 smolts, 53 adults), three fish (two smolts and one 1 SW adult) were North American X European hybrids, and one other (a precociously maturing post-smolt) was largely if not wholly European in origin.

The adult and post-smolt farmed-salmon escapees of European ancestry might have originated from the contiguous Maine salmon farming industry. Salmon of at least partial European origin, progeny of the original legal importations, are believed to be currently under culture in Maine. However, no records exist on the companies culturing them or the degree if any to which they have been hybridized with North American strains. By contrast, the escaped smolts with a partial European ancestry must have come from one of the commercial hatcheries in the Magaguadavic watershed.

4.3.3 Changes in size selective mortality in migrating smolts

The total population of 1SW and 2SW Atlantic salmon in the northwest Atlantic has been declining since the 1970s. Abnormally high marine mortality, seemingly common to all North American Atlantic salmon populations, has been observed in recent years (O'Neil *et al*. 2000). On de la Trinité river, marine survival has fluctuated from a high of 4.53% for the 1988 cohort to a low of 0.69% for those of the 1999 cohort, the last one available. Mean 1984–1999 annual smolt survival rate is 2.21%, but has recently declined. For the period 1984–1991, average marine survival of 2.96% was considered normal compared to 1.40% for the period 1992–1999, a low-survival period. One way to address the question of mortality patterns at sea is to analyse existing biological data for changes in size selective smolt mortality over time to determine if size selectivity has change in recent years. Patterns in size-selective mortality were examined for periods of normal and low marine survival, using 3-yr-old smolt from 1984 and 1985 (normal marine survival) and 1994 and 1995 (low marine survival) and the adults from these cohorts after 1 and 2 years at sea. Size at smoltification during outmigration was compared with size at smoltification back calculated from the scales of returning adults after one (1SW) and two years (2SW) at sea. In all cases, mortality selected against the smaller smolts, resulting in a higher mean size for the smolt back calculated from the adults. A second analysis was conducted to determine if these selective mortalities of smaller smolt were different between years of better (1984–1985) or poorer (1994–1995) marine survival. There was a significant increase in size selective mortality for the 1SW fish ($P<0.003$) and the 2SW fish ($P<0.001$) between periods, particularly for 2SW salmon. These preliminary results of increased mortality at sea of smaller smolt in recent years indicated that marine mortality had increased. This may be explained by an increase in predation or a change in environmental conditions such as water temperature. ICES recommends that further studies on size selective marine mortality covering additional rivers and more years be undertaken to test these hypotheses.

4.3.4 Setting biological reference points for Atlantic salmon in the NEAC area using SR data from Index rivers

It is important to know if the SR information from the index rivers can be used to set BRPs for all the NEAC salmon rivers while accounting for the major sources of variation among rivers. A meta-analysis using hierarchical modeling (Bayesian Hierarchical Analysis) provides a framework for integrating the uncertainty in transporting stock and recruitment data from well studied rivers to rivers where this information is not available.

This hierarchical SR model is an extension of a standard single river SR model. It acknowledges that all the NEAC salmon rivers are members of a family of rivers and thus any knowledge gained on the *SR* parameters for one can provide information about the same parameters on another. Provided the data are available, new covariates can be introduced along the same line, as the link can be modeled with parameter(s) of interest. Two new covariates were considered i.e., wetted area which constrains juvenile production and secondly, latitude, as there is a latitudinal gradient in the age at which salmon smoltify in Atlantic salmon. This gradient reflects the influence of latitude on the riverine ecological processes of salmon production. Both can be measured relatively easily for any river and both have shown potential for developing conservation limits for all river within regions. Aggregating conservation limits between and among regionals will be a key element in the development of scientific advice in future.

An example was presented for the rivers in Brittany region (France). There are 29 salmon rivers in Brittany of varying size located between 48° and 48.5° north. The posterior distribution of the Brittany CL was shown to be more precise than that of its individual rivers components and illustrates the potential of the approach for a broader scale CL setting exercise over the NEAC area. The same approach could be easily extended to the NAC area. This approach also complements the type of risk analyses being developed over recent years to provide catch advice. Finally, it relates the index rivers programs with the stock management issues arising from mixed stock fisheries.

4.3.5 Salmon stocks listed as endangered

Wild Atlantic salmon of the inner Bay of Fundy (iBoF) are known to have occupied at least 32 rivers (22 rivers of SFA 22 in Nova Scotia and 10 rivers in SFA 23, New Brunswick). Additional populations were suspected to have occupied all rivers and streams where migration was not obstructed by natural barriers. Rivers in these areas have a variety of habitats and are well suited to the production of salmon. In general, habitat is impacted by forest harvesting and agriculture practices to varying degrees but because of the underlying geology, waters in rivers of the iBoF are not susceptible to acidification. Some rivers have lost their salmon production because of man-made barriers to migration, reduced fish passage and resulting loss in productive capacity. On the basis of data collected to 1999, these salmon were classified as "endangered" by the Committee On the Status of Endangered Wildlife in Canada (COSEWIC) in May, 2001. In an attempt to prevent the extirpation of inner Bay of Fundy salmon a live gene bank program was initiated in 1998. Large numbers of fish and eggs of various ages are presently held in the Biodiversity Facilities.

The only persistent wild populations of Atlantic salmon remaining in the USA are currently found in eight rivers within the Gulf of Maine. Major threats to salmon continue to be poor marine survival, water withdrawals, disease, and aquaculture impacts. While it is unlikely that any Atlantic salmon populations in the USA exist in a genetically pure native form, present populations are considered descendants of aboriginal stocks and their continued presence in indigenous habitat indicates that important heritable local adaptations still exist. This information, along with low abundances, contributed to listing the Gulf of Maine Distinct Population Segment (DPS) as a federally endangered species on December 17,2000. Eight populations are currently recognized as meeting this definition. River-specific broodfish are currently used to supplement six of the eight endangered populations. All broodfish are genetically characterized which helps managers maintain the genetic integrity of wild and captive fish, prevent irreversible losses of genetic diversity, and evaluate the stocking program. Salmon taken for from DPS rivers for hatchery broodstock purposes, and captive progeny from these salmon, are protected as endangered species.

4.3.6 Biological reference points for North Atlantic salmon

The ICES Working Group on North Atlantic salmon proposed S_{MSY} as a reference point before the concept of Limit Reference Points (LRP) was introduced. At this time it was termed the 'Spawning Target' and was used as a 'Target Reference Point'. In 1998, NASCO formally adopted the precautionary approach, and accepted S_{MSY} as the Conservation Limit (CL) for salmon stocks.

ICES considers it important to define a biological reference point for salmon that can be objectively defined for all stock-and-recruitment relationships in order to ensure a consistent approach across the large number of salmon stocks in the North Atlantic.

ICES defines a stock to be outside safe biological limits when it '*suffers increased risk of low recruitment, i.e., average recruitment will be lower than if the stock were at its full reproductive capacity*'. $\mathbf{B}_{lim}$ is defined by ICES as '*the limit spawning stock biomass below which recruitment is impaired or the dynamics of the stock are unknown*'. The current use of S_{MSY} as a limit reference point is consistent with the above definitions. However, in order to ensure consistency of advice being provided by ICES, the term S_{lim} (referenced to numbers of fish) will be used and will serve as a proxy for $\mathbf{B}_{lim}$ (referenced to the biomass).

Although ICES has continued to provide more risk averse catch options, NASCO has in the past used the 50% probability level when setting quotas. By doing so, the S_{MSY} (now S_{lim}) has been used as a 'Target Reference Point' rather than a limit reference point. The latter would require the adoption of a higher probability level.

In the provision of advice for other fisheries and stocks, ICES has introduced precautionary reference points for biomass (**B**$_{pa}$) and fishing mortality (**F**$_{pa}$). The equivalent terminology if applied for salmon advice would then be referred to as S_{pa}. To date no work has been carried out to develop S_{pa} for the provision of catch advice. Such a reference point should include the uncertainties in deriving S_{lim} and uncertainties in the estimate of the predicted pre-fishery abundance (PFA).

Further modelling and analyses are required to evaluate the consequences of allowing stocks to fall below S_{lim} under varying levels of probability (e.g., 50%, 75%, 90%) to improve the advice to managers. A dialogue with managers concerning their objectives will be useful input to this work.

4.3.7 Compilation of Tag Releases and Finclip Data by ICES Member Countries in 2001

Data on releases of tagged, fin-clipped, and marked salmon in 2001 were provided and are compiled as a separate report. A summary of Atlantic salmon marked in 2001 is given in Table 4.3.7.1. About 3.88 million salmon were marked in 2001, an increase from the 3.63 million fish marked in 2000. Primary marks are summarized in three classes: microtag (i.e., coded wire tag), external tag/mark, and adipose clips (without other external marks or fin clips). Secondary marks, primarily adipose clips on fish with coded wire tags, are also presented in the Annex. The adipose clip was the most used primary mark (2.97 million), with microtags (0.52 million) the next most used primary mark. Most marks were applied to hatchery-origin juveniles (3.82 million), while 39,790 wild juveniles and 19,081 adults were marked.

5 ATLANTIC SALMON IN THE NORTH-EAST ATLANTIC COMMISSION AREA

5.1 Events of the 2001 Fisheries and Status of Stocks

5.1.1 Fishing in the Faroese area 2000/2001 commercial fishery

No fishery for salmon was carried out in 2001 or, to date, in 2002. Consequently, no biological information is available from the Faroese area for this season. No buyout arrangement has been made since 1999.

5.1.2 Homewater fisheries in the NEAC area

Gear and effort: While there have been no changes in the types of commercial fishing gear used, the number of licensed gear units has, in most cases, continued to fall. Most fisheries for which data are available record a reduction of over 40% in gear units operated over the last 10 years. There are no such consistent trends for the rod fishing effort in NEAC countries over this period. Further initiatives to reduce fishing effort were introduced in several countries.

Catches: In the NEAC area there has been a general reduction in catches since the 1980s. This reflects a decline in fishing effort as a consequence of management measures and the reduced value of commercially caught salmon, as well as a reduction in the size of stocks. However, the overall nominal catch in the NEAC area in 2001 (2,887 t) was 6% higher than the catch in 2000. Compared to the 2000, catches in both southern and northern areas were higher by 4% and 8 % respectively, and higher than the five year average by 9% and 34 % respectively.

CPUE: CPUE data for various net and rod fisheries indicate a general increase in Northern Europe while patterns in Southern Europe are less consistent. The reduction in the number of fisheries operating can benefit those fisheries still in operation and that the lack of consistent trends in CPUE in Southern Europe may reflect the imprecise nature of these indices.

Composition of catches: No common trends were noted in the sea age composition of the 2001 catches in the NEAC areas and there was no clear division between countries in Northern and Southern Europe. Despite the continued high levels of production in the salmon farming industry, the incidence of farmed salmon in NEAC homewater fisheries was generally low (<2%) and similar to recent years. The exception to this is Norway, where farmed salmon continue to form a large proportion of the catch in coastal, fjord and riverine fisheries.

Origin of catch: The incidence of tagged fish taken in fisheries originating from other countries was updated for Ireland. In 2001, 189 tags were recovered from releases of smolts in UK (N. Ireland), 43 from UK(England & Wales) and 2 from Spain. These recoveries were within the range of recoveries in previous years.

An update of the adult recovery information derived from tagged smolts released in Norway was made available to ICES. Between 1996 and 2000 a total of 474,342 smolts, mainly hatchery reared, were tagged and released. A total of 4,297 adult recoveries were reported from Norway and 20 from other countries (0.5% of the total number of salmon recovered). This is consistent with previous observations that very few Norwegian salmon are intercepted in other countries.

Exploitation rates: In general, the exploitation rates on salmon stocks in the Northern NEAC area, as derived from the NEAC PFA model, have remained constant or have shown a decreasing trend. Similarly, exploitation rates for Southern NEAC area have declined considerably in most countries, particularly in the last decade.

The marine survival of wild and hatchery-reared smolts in both Northern and Southern NEAC areas has declined over the past 10–20 years. The steepest decline is seen for wild smolts in Southern NEAC area, returning as 1SW salmon. Survival of both wild and hatchery fish returning as 2SW in Northern NEAC area, however, has increased in recent years.

In general, the total returns of salmon and spawning stocks in the Northern NEAC area, as derived from the NEAC PFA model has increased in recent years. In contrast, salmon stocks in Iceland show a decline since the late 1980's, especially for MSW salmon. Salmon stocks in the Southern NEAC area show a consistent decline over the past 20–30 years. This relates especially to the MSW component of the salmon stocks.

The consistent downward trends in marine survival of smolts and the estimated returns and spawners as derived from the PFA model suggest that returns are strongly influenced by factors in the marine environment.

5.2 Evaluation of the Effects on Stocks and Homewater Fisheries of Significant Management Measures Introduced Since 1991

5.2.1 Evaluation of the effects of management measures introduced in Faroes since 1991

Between 1991 and 1998 the Faroese fishermen agreed to suspend commercial fishing for the salmon quota set by NASCO, in exchange for compensation payments. The number of fish spared as a result of this period of suspension is the catch that would have been taken if the fishery had operated, minus the catch in the research fishery which operated in most years. No buyout has been arranged since 1999. As no quota was set in 2000/2001 and there was no fishery in Faroe, the analysis which was carried out for the 2000 fishery was not repeated for 2001. Also, examination of trends in catches in NEAC countries suggests that any expected increase arising from the cessation of fishing at Faroes may be masked by other factors such as changes in marine survival and/or management measures in homewaters. For information purposes, the analysis presented in last years report is reproduced below.

Although no fishing took place in 1999, a single vessel carried out commercial fishing in 2000, catching approximately 8 t. As for last year, analysis was based on the assumption that a full quota would have been taken, had full scale commercial fishing taken place. Thus, the maximum catch that would have been taken in 1999/2000 would have been 300 t (see below). For the 1999/2000 analysis therefore the fish spared totalled 292 t (300 t-8 t).

Year	Quota (t)	Estimated increased returns to home waters in Europe			
		1SW	%	MSW	%
1992	550	2 842	0	70 809	6
1993	550	11 429	1	106 307	10
1994	550	21 078	1	134 159	11
1995	550	12 949	1	138 533	13
1996	470	10 573	1	122 196	12
1997	425	9 578	0	105 368	14
1998	380	19 699	1	103 169	13
1999	330	17 261	1	99 130	12
2000	300	15 332	1	87 726	10

The calculated additional returns represent between 6% and 14% of MSW fish and up to 1% of 1SW fish returning to homewaters between 1992 and 2000. However, about 65% of MSW salmon caught in the Faroes fishery would return to Scandinavian countries, Finland and Russia. If this were the case, they might have represented from 10% to 19% of MSW returns and up to 2% of 1SW returns to northern European homewaters in those years. If stocks and fisheries had remained stable, total catches would have been expected to increase by approximately the same proportions in respective areas.

5.2.2 Evaluation of the effects of management measures introduced in homewaters since 1991

There have been significant reductions in the number of gear units deployed in most countries in the NEAC area since 1991. Several have also introduced a number of other which include: restrictions on fishing seasons, buy-out arrangements, voluntary restrictions and increasing use of catch and release.

Both fishing effort and reported catches were believed to have increased in some NEAC net fisheries due to the anticipation of quota management systems based on historical catches or a presumption that buyouts and/or set-asides might be implemented in the future. It was not possible to quantify these increases.

The effect of specific management measures on stocks and fisheries has been evaluated in a number of NEAC countries.

NEAC northern area: The buy-out of gillnets in the Hvita river system in Iceland is estimated to have improved the rod catch in tributaries of the river by 28 to 35%. The increase in rod catches also suggested that the rod fishery may be taking 39 to 52% of the previous net catch. In Russia, commercial catches in the 1990s are estimated to be 3.5 times smaller than in the 1980s largely as a result of management changes aimed at reducing the fishing effort and a cessation of the salmon fishery on the Pechora River, in particular.

NEAC southern area: In UK (England and Wales), the North East coast fishery is the largest net fishery and has taken, on average, 68% of the national declared net catch over the period 1970–1992. A phase out of this fishery was introduced in 1993 and the number of licences issued has subsequently fallen from 142 in 1992 to 70 in 2001 (51%). The exploitation rate in 1992 was estimated to be in the region of 50%. Assuming the remaining fishermen are representative and that there have been no major changes in the fishery, the average exploitation rate (1997–2001) would have fallen to around 30% (i.e., a 40% reduction). This is greater than the reduction in the average drift net catch (1997–2001), which has fallen by 22% compared with the 5 years (1988–92) prior to the start of the phase out. A number of other smaller coastal mixed stock fisheries have also been phased out since 1991.

National measures were introduced in UK (England and Wales) in 1999 to protect spring salmon. In 2001, these are estimated to have saved around 3,100 salmon from capture by net fisheries and around 1,100 by rod fisheries before June 1. These estimates are based on the catch and the average proportion of fish taken in this period in the 5 years prior to the measures being introduced; the latter estimate has been adjusted for catch and release.

In Scotland, members of the Salmon Net Fishing Association, to which the majority of active netsmen are affiliated, continued a voluntary agreement, introduced in 2000, to delay fishing until the beginning of April in order to protect early running MSW salmon. Similar delays to the start of the season were also introduced in Sweden.

In Ireland, the introduction of measures in the commercial fishery in 1997 effectively reduced effort in the commercial fishery by about 20% (5 to 4 days per week). Further restrictions on night-time fishing further reduced the effort by up to 50% in some areas where all day fishing was previously carried out. Fishing effort on spring salmon stocks was also reduced with the later opening of the season for some gears. A more detailed appraisal of these methods on Irish monitored stocks was presented in last year's Working Group report (ICES 2001, ACFM:15) which concluded that the measures contributed to a reduction in both the overall catch and the exploitation rate on Irish stocks. Exploitation rate estimates in net fisheries for tagged wild and hatchery stocks for 2001 were below recent long-term averages; this was felt to reflect the recent management changes.

In northern France, TACs have been operated in several regions for some years. In Brittany (which provides more than 60% of the total catch) a MSW specific TAC, introduced in 2000, continued to apply and resulted in the temporary closure of some rod fisheries in 2001. One and two month delays to the start of the angling season were also introduced on three other rivers, in an effort to reduce exploitation of spring salmon. However, catch data suggest that this resulted in catches well above average when the season commenced, suggesting that the measures merely delayed exploitation. In addition, a six-week closure of the net fishery took place in the Adour estuary in June and July 2001; this is estimated to have saved around 6,500 1SW salmon.

The above estimates and the overall reduction in gear units suggest that the impact of fisheries on NEAC stocks has been significantly reduced since 1991.

5.3 Expected Abundance of Salmon in the North East Atlantic

Previous developments and improvements to the NEAC PFA Model

ICES has previously developed a model to estimate the pre-fishery abundance (PFA) of salmon from countries in the NEAC area. PFA in the NEAC area is defined as the number of 1SW recruits on January 1st in the first sea winter. The method employs a basic run-reconstruction approach similar to that described by Rago *et al.* (1993) and Potter and Dunkley (1993). The model estimates the PFA from the catch in numbers of 1SW and MSW salmon in each country. These are raised to take account of minimum and maximum estimates of non-reported catches and exploitation rates of these two sea-age groups. Finally these values are raised to take account of the natural mortality between January 1st in the first sea winter and the mid-point of the respective national fisheries. No significant changes were introduced to the model in 2002, although further improvements were made to the data inputs by some countries. In addition, as discussed in Section 4.2, a value of 'M' of approximately 0.03 per month is more appropriate than the previous value of 0.01 and a range from 0.02 to 0.04 has therefore been used in the PFA model.

Stock groupings for the NEAC PFA analysis

Each year, NASCO asks for a description of events in the salmon fisheries and the status of salmon stocks, and for management advice for the major salmon fisheries. As there are over 1,600 salmon stocks in the NEAC area, it is necessary to group stocks when providing this advice. ICES has previously provided information on the status of stocks by river or by country, and used the following groups of countries to combine the PFA estimates for managers (e.g., ICES 2001/ACFM:15):

Southern European countries:	Northern European countries:
Ireland	Finland
France	Norway
UK(England & Wales)	Russia
UK(Northern Ireland)	Sweden
UK(Scotland)	Iceland

These groupings represent a convenient geographical split delimited by the North Sea. It also roughly separates the two groups of European stocks (southern and northern) that have previously been considered to make the greatest contribution to the West Greenland and Faroes fisheries respectively.

In order to determine the stock groups for the provision of management advice for the Faroes and West Greenland fisheries, comparable indices of exploitation were estimated for national salmon stocks. These were based upon the 10-year average of national PFA estimates and the relative contribution of national stocks to the fisheries from tag recoveries (i.e., the recovery rate per 1,000 tags released). These are shown in Figure 5.3.1 for 1SW and MSW salmon in the Faroes fishery and MSW salmon in the West Greenland fishery. There is no apparent pattern in the levels of exploitation in the Faroes fishery, for either 1SW or MSW salmon. However, there is a clear pattern for MSW salmon at West Greenland, with very low indices of exploitation for Russia, Norway, Sweden and Iceland, but increasing indices for more southerly European countries.

On this basis it was proposed that advice for the Faroes fishery (both 1SW and MSW) should be based upon all NEAC area stocks, but that advice for the West Greenland fishery should be based upon Southern European MSW salmon stocks only (comprising UK, Ireland and France).

Sensitivity analysis of the NEAC PFA model: A sensitivity analysis for the spreadsheet model, which generates pre-fishery abundance (PFA) estimates in the NEAC area was described in ICES 2001/ACFM15. The sensitivity of the overall assessment of PFA for the NEAC Area and for the Northern and Southern European stock complexes depends on the values of the various parameters provided for different countries, and these will also be weighted by the national catches. Changes to the parameter values effect the respective PFA estimates to varying degrees. The analysis also indicates that increasing 'M' from 0.03 to 0.04 per month for all the national data sets would increase the PFA estimates for maturing 1SW salmon by about 8% and for non-maturing 1SW salmon by about 19%.

At this level of disaggregation the model is fairly sensitive to some parameter values and therefore great care should be taken to ensure their accuracy:

Country (Region)	Sea-age	Parameter
Norway (mid)	1SW	non-reporting rate
Norway (North)	MSW	non-reporting rate
Ireland	1SW	non-reporting rate
Ireland	1SW	exploitation rate
Scotland (East)	1SW	exploitation rate
Scotland (East & West)	MSW	exploitation rate
Scotland (East)	MSW	non-reporting rate

Changes to the national Conservation Limits model

In 2001 a new method for setting biological reference points from "noisy" (uncertain) stock-recruitment relationships, such as provided by the national pseudo-stock-recruitment datasets (ICES CM2001/ACFM:15) was adopted. This model assumes that there is a stock level below which recruitment decreases linearly towards zero stock and recruitment, and above which recruitment is constant. Given the current knowledge, this stock level can be considered as a proxy for S_{lim} and is therefore defined as the conservation limit for salmon stocks. The model provides a more objective method for estimating these reference points than the non-parametric methods previously used.

Potter and Nicholson (2001) described a modified version of this method, which updates the method first used by ICES in 2001, by allowing uncertainty around these estimates to be described. The model also allows two probability levels to be inserted to generate upper confidence limits only (it is assumed that only more conservative CLs will be required if uncertainty is incorporated). The output from the model is shown in three embedded figures (Figure 5.3.2):

Panel 1 shows the stock-recruitment relationship with the fitted model;

Panel 2 shows the time series of stock estimates;

Panel 3 shows a plot of the residual sum of squares for values of Sc (the stock level at the inflection point).

ICES concluded this approach was more appropriate for future evaluation of the national conservation limits as it allows uncertainty around these CLs to be estimated and this information can be employed in providing precautionary management advice. Hence, this approach was applied to the 2001 national stock-recruitment relationship assessment.

Forecasting PFA for NEAC stocks: ICES considered the development of a model to forecast the pre-fishery abundance of non-maturing (potential MSW) salmon from the Southern European stock group (comprising Ireland, France and all parts of UK). Stocks in this group are the main European contributors to the West Greenland fishery. The objective was to use the model fitted to data from 1977–2000 to predict *PFA* in the subsequent years 2001–2002.

The data to be used in the model consisted of:

- *PFA*: the pre-fishery abundance of MSW salmon from Southern Europe for the period 1977–2000 was taken from the output of NEAC PFA model as reported in Section 6.3.4.
- *Stock*: the index used in the model is the 'lagged egg' numbers for the period 1977–2002 derived from the national PFA and CL analysis;

- *Habitat*: the same habitat index was used as in the North American PFA prediction model. This thermal habitat is defined as a relative index of the area suitable for salmon at sea and was derived from sea surface temperature (SST) data obtained from the National Meterological Centre of the National Ocean and Atmospheric Administration and previously published catch rates for salmon from research vessels fishing in the north-west Atlantic (as used in the current North American forecast model, Section 4).

The forecasts using this model and the probability distribution are given in Table 5.3.1. The model forecasts that, in 2002, the Southern European MSW stock will fall to around 552,000. This is about one third of the estimated PFA in the mid 1970s, and lower PFA levels have only been estimated for three years (1996 to 1998). Although the model is not strongly driven by Egg Nos, this decline is consistent with the continuing decline in estimated egg deposition.

5.4 Development of Age-Specific Conservation limits

In all, there are around 15–25 stock and recruitment datasets in the NEAC area, ranging from long time series to rivers where stock-recruitment (S/R) relationships are in the process of being (or could be) developed. These include a mixture of smaller rivers and tributaries of large river systems. Given the time and resource difficulties with collecting meaningful S/R data, it is unlikely that many further datasets will be developed in the near future. However, as these rivers are spread throughout the NEAC area and cover a wide array of river types and productivity levels, even incomplete S/R datasets may provide useful information for helping to identify BRPs for transport of conservation limits to rivers with little or no data.

These and related issues are being dealt with by the EU funded SALMODEL Concerted Action "*A co-ordinated approach towards the development of a scientific basis for management of wild Atlantic salmon in the North-East Atlantic*" (Contract No**:** QLK5-CT1999–01546; www.salmodel.net). A brief summary of the areas under consideration and where progress is being made is given below:

- Developing common methods of setting conservation limits
- Transporting SR relationships to rivers where no s/r data exist
- Non-stationarity in SR relationships
- The effect of sea trout on setting CLs
- The genetic implications of CL limits
- Risk in setting CLs
- Alternative methods for setting CLs

5.5 Catch Options or Alternative Management Advice

IES has been asked to provide catch options or alternative management advice with an assessment of risks relative to the objective of exceeding stock conservation limits in the NEAC area. ICES reiterated its concerns about harvesting salmon in mixed stock fisheries, particularly for fisheries exploiting individual river stocks and sub-river populations that are at unsatisfactorily low levels. Annual adjustments in quotas or effort regulations based on changes in the mean status of the stocks are unlikely to provide adequate protection to the individual river stocks that are most heavily exploited by the fishery or are in the weakest condition.

ICES also emphasized that the national stock conservation limits discussed above are not appropriate for the management of homewater fisheries, particularly where these exploit separate river stocks. This is because of the relative imprecision of the national conservation limits and because they will not take account of differences in the status of different river stocks or sub-river populations. Nevertheless, ICES agreed that the combined conservation limits for the main stock groups (national stocks) exploited by the distant water fisheries could be used to provide general management advice for these fisheries.

Despite resolution of some uncertainties about the most appropriate stock groupings (section 6.3.6), because of the preliminary nature of the conservation limit estimates, ICES is unable to provide quantitative catch options for most stock complexes at this stage. In the absence of predictive estimates of PFA and more reliable estimates of conservation limits, it is unlikely that quantitative catch advice will be developed in the immediate future. An exception this year is the provision for the first time of a quantitative prediction of PFA for southern European MSW stocks (Section 6.5.2). ICES feels that the following qualitative catch advice is appropriate based upon the PFA data and estimated SERs shown in Figures 5.3.3.to 5.3.8.

- Based on recent work on resolving the most appropriate stock groupings for management advice for the distant water fisheries, ICES agreed that advice for the Faroes fishery (both 1SW and MSW) should be based upon all NEAC stocks. Advice for the West Greenland fishery should be based upon southern European MSW salmon stocks only (comprising UK, Ireland and France).

- For all fisheries, ICES considers that management of single stock fisheries should be based upon local assessments of the status of stocks. Conservation would be best achieved by fisheries in estuaries and rivers targeting stocks, which have been shown to be above biologically-based escapement requirements.

- While and estimate of unreported catches have been included in the assessment, there is a need to obtain more precise estimates or to increase the precision of reporting in future.

- It should be noted however that the inclusion of farmed fish in the Norwegian data will result in the exploitable surplus being overestimated for both maturing and non-maturing PFA estimates for the Northern European catch advice.

Northern European 1SW stocks: The PFA of 1SW salmon from the Northern European stock complex has been above the spawning escapement reserve throughout the time series (Figure 5.3.5), with some evidence of an upturn in the past few years. However, the spawning escapement was below the conservation limit until 1987 (Figure 5.3.6). This upward trend was continued with a slight reduction in 1SW spawners relative to 2000. ICES considers that overall exploitation of the stock complex at the current rate is acceptable, although this should not increase as the status of individual stocks varies considerably. Since very few of these salmon have been caught outside homewater fisheries in Europe, even when fisheries were operating in the Norwegian Sea, management of maturing 1SW salmon should be based upon local assessments of the status of river or sub-river stocks.

Northern European MSW stocks: The PFA of non-maturing 1SW salmon from Northern Europe has been declining since the mid 1980s and the exploitable surplus has fallen from around 1 million recruits in the 1970s to about half this level in recent years (Figure 5.3.5). ICES considers the Northern European MSW stock complex to be within safe biological limits, as spawners are above CL and trending in a positive direction (Figure 5.3.6), although it is recognised that the status of individual stocks will vary considerably. ICES therefore considers that caution should still be exercised in the management of these stocks particularly in mixed stock fisheries and exploitation should not be permitted to increase until a clear pattern of status above SER is established.

Southern European 1SW stocks: Recruitment of maturing 1SW salmon in the Southern European stock complex has shown a strong decreasing trend throughout most of the time series (Figure 5.3.7). Moreover the spawning escapement for the whole stock complex has fallen below the conservation limit in four of the past five years (Figure 5.3.8). Despite a small surplus above SER of around 300,000 fish during the last two years, exploitation in those years was clearly high enough to prevent conservation requirements being met. ICES therefore considers that reductions in exploitation rates are required for as many stocks as possible and that mixed stock fisheries present particular threats to conservation.

Southern European MSW stocks: The PFA of non-maturing 1SW salmon from Southern Europe has been declining steadily since the 1970s (Figure 5.3.7), and the preliminary quantitative prediction of PFA for this stock complex indicates that PFA will remain close to present low levels for each of the next two years. The spawning escapement has not been significantly above conservation limit for the last six years and there is evidence from the prediction that PFA will decrease in the near future (Figure 5.3.8). The stock group is therefore thought to remain very close to safe biological limits, and ICES therefore considers that precautionary reductions in exploitation rates are required for as many stocks as possible, in order to ensure that conservation requirements are met for each river stock with high probability. ICES also notes that mixed stock fisheries present particular threats to conservation.

5.6 Estimates of by-catch of post-smolts in pelagic fisheries in the Norwegian Sea

Atlantic salmon post-smolts have been observed to overlap in time and space with some of the mackerel fishing areas in the North East Atlantic (ICES 2000/ACFM:13), and both species seem to follow the warm and saline Atlantic current on their northward migration. The potential risk of salmon post-smolts being taken in commercial fisheries for pelagic fish has been discussed for some time, but so far little substantial data to estimate this has been available.

In June 2001 the Institute of Marine Research ran a dedicated salmon survey west of the Voering Plateau in the Norwegian Sea, at approximately the same time as the commercial mackerel fishery starts in these areas. During this survey large catches of mackerel were made and these catches contained a varying number of post-smolts. The simultaneous occurrence of salmon and post-smolts in areas where the commercial fleet is known to operate, gave for the first time the possibility to examine the magnitude of the by-catches of post-smolts of salmon in the commercial fishery.

Although the presented methods are preliminary and under development, they represent the first attempt to estimate the by-catch of salmon post-smolts in the mackerel fishery in the Norwegian Sea based on observed data.

A total of 198 post-smolts were captured simultaneously with 7,959 kg mackerel. The proportion of post-smolts per weight of the mackerel captured in the 2001 research fishery was used to scale up with the registered commercial trawl captures in the Norwegian Sea (ICES Divisions IIa and Vb) in 2nd and 3rd quarter in 2000.

Estimates of post-smolt by-catches can be obtained assuming that the catches from the research fishery are representative for the commercial fishery. Unfortunately, mackerel catch data for 2001 were not available and therefore the catch for 2000 (38,000 tons) was used in this calculation. Two estimates for scaling up the post-smolt catches applying mackerel trawl catches in the Norwegian Sea are: (1) The total number of post-smolts per kg mackerel caught gives 950,000 post-smolts in numbers) while (2) the unweighted mean of the number of post-smolts per kg mackerel caught per individual tow suggests 608,000 post-smolts in numbers. These figures can be compared with the current total PFA estimates for the Northeast Atlantic in 2001, which was approximately 3.6 million (immature and maturing) salmon.

Only the commercial trawl catch from the above mentioned ICES Divisions have been used in the calculations because the research data are obtained by pelagic trawling and the only commercial operation that these data could possibly be representative of would be the pelagic trawl fishery.

Caution is advised when interpreting the results. It is not known how well results from commercial and scientific trawl operations compare, e.g., there are difference in trawl size and towing speed. Also, fishing areas vary from year to year due to environmental factors, stock size, and quota limitations for the participating nations. However, the distribution of commercial mackerel catches 1977 – 2000 (Figure 5.3.11) and the distribution of post-smolt captures taken in the Norwegian research surveys in 1990 – 2000 (Figure 5.3.12), overlap, giving some justification for the approach applied.

These estimates serve to illustrate that by-catch is potentially significant. However, more directed work is needed to demonstrate that the post-smolt catches are proportional to the actual landings made by the mackerel fisheries in the same area and at the same time. These first estimates could be improved by continuing to develop and expand the surveys in the actual areas and by obtaining direct by-catch estimates from the mackerel fleet. To increase the precision in the estimates, the commercial catches of mackerel in the Norwegian Sea (ICES Divisions IIa and Vb), Northern North Sea (IVa) and west of Ireland and Scotland (Divisions VIa,b; VIIb,c,j,k) should be examined by ICES Divisions and per standard week during the period May-August (week 18–33). With the captures broken down into catches per standard week by Division, the possibility of a more precise assessment of the potential by-catch of posts-smolts in these areas can be examined. Information on the proportion of the catches made by seiners and trawlers would also be important for the assessments.

5.7 Data deficiencies and research needs in the NEAC Area

1. To improve the input of environmental variables in the predictive models, research on temporal and spatial distribution on salmon post-smolts of different origin in the ocean should be continued and expanded. Two approaches are recommended: (a) a co-ordinated tagging program of salmon smolts throughout the distribution range followed by intensive sampling of returning fish in local and distant waters. (b) tagging smolts with Data Storage Tags.

2. To improve the estimates of by-catch of post-smolts in the mackerel fishery, a continuing effort to develop and expand the surveys in the actual areas is required. Furthermore, the commercial catches of mackerel in the Norwegian Sea (ICES Divisions IIa and Vb), Northern North Sea (IVa) and west of Ireland and Scotland (VIa,b; VIIb,c,j,k) should be provided by ICES Divisions and per standard week during the period May-August (week 18–33).

3. Research on post-smolts in the early marine phase should be continued and expanded. This should include studies on interactions with parasites and assessments of the impact of sea lice on post-smolts.

4. Further progress should be made in establishing PFA methodologies.

5. Further progress is needed in establishing the actual levels of unreported catch and reducing these unreported catches as much as possible.

6 ATLANTIC SALMON IN THE NORTH AMERICAN COMMISSION AREA

6.1 Events of the 2001 fisheries and status of stocks

6.1.1 Fisheries in the NAC area

Gear and effort: The 23 areas for which the Department and Fisheries and Oceans (DFO) manages the salmon fisheries are called Salmon Fishing Areas (SFAs); for Québec, the management is delegated to the Société de la Faune et des Parcs du Québec and the fishing areas are designated by Q1 through Q11 (Figure 6.1.1.1). Three user groups exploited salmon in Canada in 2001: Aboriginal peoples, residents fishing for food in Labrador and recreational fishers. Hence there were no commercial fisheries in Canada in 2001.

<u>Aboriginal peoples' food fisheries</u>: In Québec, Aboriginal peoples' food fisheries took place subject to agreements or through permits issued to the bands. In the Maritimes and Newfoundland (SFAs 1 to 23), food fishery harvest agreements were signed with several Aboriginal peoples groups (mostly First Nations) in 2001. The signed agreements often included allocations of small and large salmon. Under agreements reached in 2001, several Aboriginal communities in Nova Scotia were permitted to retain "adipose clipped" 1SW salmon from 5 Atlantic coast rivers using methods that permitted live release of wild fish.

<u>Residents food fisheries in Labrador</u>: In the Lake Melville (SFA 1) and the coastal southern Labrador (SFA 2) areas, DFO allowed a food fishery for local

residents to retain a maximum of four (4) salmon of any size while fishing for trout and charr; 4 salmon tags accompanied each license. The license restricted the fishing gear to a gillnet of 15 fathoms (27.4 m) and 3.5 in (89 mm) mesh. The seasons were June 15-July 2 and July 24-August 19 in SFA 1 and July 15-August 31 in SFA 2. All licensees were to complete logbooks.

Recreational fisheries: Recreational fisheries management in 2001 varied by area. Except in Québec and Labrador (SFA 1 and 2), only small salmon could be retained in the recreational fisheries. Other measures included seasonal and daily bag limits, hook and release fisheries and total closures.

There was no fishery for sea-run Atlantic salmon in the USA in 2001; as a result of angling closures since 1999, effort measured by license sales, was 0.

For the Saint-Pierre and Miquelon fisheries in 2001, there were 10 professional and 42 recreational gillnet licenses issued. The number of professional fishermen has increased by two licenses from 2000 and the number of recreational licenses increased by seven licenses since 2000, the maximum level encountered since 1995. No salmon fishing was allowed within 360 m of the mouths of two rivers (Belle-Riviere and Dolisie), as there are indications of salmon spawning in these rivers.

Year	Number of Professional Fishermen	Number of Recreational Licenses
1995	12	42
1996	12	42
1997	6	36
1998	9	42
1999	7	40
2000	8	35
2001	10	42

Catch: The provisional harvest of salmon in 2001 by all users was 145 t, about 5% less than the 2000 harvest of 153 t (Table 4.1.1.1). The 2001 harvest was 48,760 small salmon and 12,102 large salmon, 12% fewer small salmon and 15% more large salmon, compared to 2000. The dramatic decline in harvested tonnage since 1988 is in large part the result of the reductions in commercial fisheries effort, the closure of the insular Newfoundland commercial fishery in 1992, the closure of the Labrador commercial fishery in 1998 and the closure of the Québec commercial fishery in 2000. These reductions were introduced as a result of declining abundance of salmon.

The 2001 harvest of small and large salmon, by number, was divided among the three user groups in different proportions depending on the province and the fish-size group exploited. Newfoundland reported the largest proportion of the total harvest of small salmon and Québec reported the greatest share of the large salmon harvest. Recreational fisheries exploited the greatest number of small salmon in each province, accounting for 84% of the total small salmon harvests in eastern Canada. Unlike years previous to 1999 when commercial fisheries took the largest share of large salmon, food fisheries (including the Labrador resident food fishery) accounted for the largest share in 2001 (55% by number).

Aboriginal peoples' food fisheries. Harvests in 2001 (by weight) were up 12% from 2000 and 14% above the previous 5-year average harvest. In some cases, particularly in the Maritime provinces, Aboriginal peoples' food fisheries harvests in 2001 were less than the allocations.

Residents Fishing for Food in Labrador: The estimated catch for the entire fishery in 2001 was 5.0 t, about 2,100 fish (76% small salmon by number).

Recreational fisheries: Harvest in recreational fisheries in 2001 totalled 46,446 small and large salmon, 16% below the previous 5-year average and 8% below the 2000 harvest level (Figure 4.1.2.2). The small salmon harvest of 40,948 fish was a decrease of 16% from the previous 5-year mean. The large salmon harvest of 5,498 fish was a 10% decline from the previous five-year mean. Small and large salmon harvests were down 11% and up 19% from 2000, respectively.

Hook-and-released salmon fisheries: In 2001, about 56,600 salmon (about 25,400 large and 31,200 small) were caught and released (Table 4.1.2.2), representing about 55% of the total number caught. This was a 9% decrease from the number released in 2000. Most of the fish released were in Newfoundland (44%), followed by New Brunswick (43%), Québec (10%), Nova Scotia (3%) and Prince Edward Island (0.3%). Expressed as a proportion of the fish caught, that is, the sum of the retained and released fish, Nova Scotia released the highest percentage (90%), followed by New Brunswick (60%), Newfoundland (55%), Prince Edward Island (47%) and Québec (37%).

All fisheries (commercial and recreational) for sea-run Atlantic salmon within the USA are now closed, including rivers previously open to catch-and-release fishing. Thus, there was no harvest of sea-run Atlantic salmon in the USA in 2001. Unreported catches in the USA were estimated to be 0 t.

For Saint Pierre et Miquelon. the harvest in 2001 was reported to be 2.2 t from professional and recreational fishermen, approximately the same as 1998 through 2000. Professional and recreational fishermen caught 1 544 and 611 kg of salmon, respectively. There was no estimate available of unreported catch for 2001.

Composition and origin of catch: In the past, salmon from both Canada and the USA have been taken in the commercial fisheries of eastern Canada. These fisheries have since been closed. The remaining Aboriginal Peoples' and resident food fisheries that exist in Labrador may intercept some salmon from other areas of North America although there are no reports of tagged fish being captured there in 2001. The fisheries of Saint-Pierre and Miquelon catch salmon of both Canadian and US origin. Little if any sampling occurs in these remaining fisheries.

The returns to the majority of the rivers in Newfoundland and to most rivers of the Gulf of St. Lawrence and Québec were comprised exclusively of wild salmon. Hatchery origin salmon made up varying proportions of the total returns and were most abundant in the rivers of the Bay of Fundy, the Atlantic coast of Nova Scotia and the USA.

Aquaculture escapees were noted in the returns to seven rivers of the Bay of Fundy and the coast of Maine (Saint John, Magaguadavic, St. Croix, Union, Dennys, Narraguagus and Penobscot). However, their numbers in the Saint John and Penobscot Rivers were low (14 and 1 respectively) and composed less than 0.01% of the returns. In the Magaguadavic River (SFA 23), which is located in close proximity to the centre of the aquaculture production area, the proportion of the adult run composed of aquaculture escapees has been high (greater than 50%) since 1994. Escaped fish were not observed between 1983 and 1988. Since 1992, escaped fish have comprised between 33% and 90% of adult salmon counts. However, while farmed fish have dominated the run in terms of percentages, in absolute terms their numbers showed a declining trend up until 2000. In 2001, this trend was reversed and four times more escapees (132) entered the river than in the previous year. An upturn compared to 2000 of escapees in the returns to the nearby St. Croix River was also noted. Farm escapees were also monitored in US rivers of Maine's with estimates of escapees ranging from 32% to 100%. These values are similar to those observed at these sites in the last few years.

Exploitation rates: In Newfoundland, exploitation rates were available for 12 rivers in 2001. For those rivers with retention of small salmon, exploitation rates ranged from 7% to 47% with a mean value of 13%. In Québec, exploitation rates were available for 35 rivers. Exploitation rates of small salmon ranged from 4% to 57% with a mean value of 33%. Retention of large salmon was permitted on 21 of those rivers; exploitation rates for large salmon ranged from 3% to 31% with a mean value of 22%. Global exploitation rates using mid-point estimates of returns and recreational landings were 17% for small salmon and 12% for large salmon. No estimates of returns to Labrador are possible for 1998 - 2001, as there was no commercial fishery and there was insufficient information collected on freshwater escapements to extrapolate to other Labrador rivers. For this reason, exploitation rates cannot be calculated for 1998 - 2001.

There was no exploitation of USA salmon in homewaters and no salmon of USA origin were reported in Canadian fisheries in 2001.

6.1.2 Status of stocks in the NAC area

Returns, recruits and spawners:

Estimated (mid-point) 1SW and 2SW returns, spawners, and spawner requirements are shown for five of six regions in North America in Figures 6.1.2.1 and 6.1.2.2. Labrador returns and thus total North American returns have been unavailable since 1998.

Trends in abundance of small salmon and large salmon within the geographic areas show a general synchronicity among the rivers. Returns of large salmon in North America were generally increased from 2000 while small salmon returns decreased. Any increases however in large salmon returns were from often record low values in 2000. For the rivers of Newfoundland, large salmon returns decreased from 2000 but remained high relative to the years before the closure of the commercial fisheries. Large salmon in Newfoundland are predominantly repeat-spawning 1SW salmon while in other areas of eastern Canada, 2SW and 3SW salmon make up varying proportions of the returns.

In most regions the returns of 2SW fish are at or near the lower end of the 31-year time series (1971–2001) except Newfoundland where they are at the sixth highest but are a minor age group component of the stocks in this area. Returns of 1SW salmon were at the lower end of the time series in Gulf, Scotia-Fundy and USA and at about at the mid-point in Québec and Newfoundland.

The rank of the estimated returns in 2001 in the 1971–2001 time series for six regions in North America is shown below. The closer the rank of returns in 2001 is to 1, the better the relative performance of the stock.

Region	Rank of 2001 returns in 1971–2001 time series (1=highest)		Mid-point estimate of 2SW spawners as proportion of conservation limit (S_{lim}) (%)
	1SW	2SW	
Labrador	Unknown	Unknown	unknown
Newfoundland	16	6	193
Québec	23	28	71
Gulf	26	26	77
Scotia-Fundy	30	28	19
USA	21	29	3

In 2001, the overall conservation limit (S_{lim}) for 2SW salmon was not met in any area except Newfoundland (Figure 6.1.2.3). The overall 2SW conservation limit for Canada could have been met or exceeded in only nine (1974–78, 1980–82 and 1986) of the past 29 years (considering the mid-points of the estimates) by reduction of terminal fisheries (Figures 6.1.2.4). In the remaining years, conservation limits could not have been met even if all terminal harvests had been eliminated. It is only within the last decade that Québec and the Gulf areas have failed to achieve their overall 2SW salmon conservation limits.

Pre-fishery abundance estimates of non-maturing and maturing 1SW North American salmon

The North American run-reconstruction model has been used to estimate pre-fishery abundance and serves as the basis of abundance forecasts used in the provision of catch advice. The definitions used in the derivation of the model are provided in Table 6.1.2.1. The catch statistics used to derive returns and spawner estimates have been updated from those used in ICES 2001/ACFM:15 (Table 6.1.2.2). The North American run-reconstruction model has also been used to estimate the fishery exploitation rates for West Greenland and in homewaters.

Estimates of pre-fishery abundance suggest a continuing decline of North American adult salmon over the last 10 years. The total population of 1SW and 2SW Atlantic salmon in the northwest Atlantic has generally been declining since the 1970s, and the abundance recorded in 1993–2001 was the lowest in the time series (Figure 6.1.2.5). During 1993 to 2001, the total population of 1SW and 2SW Atlantic salmon was about 600,000 fish, about half of the average abundance during 1972 to 1990. The decline has been more severe for the 2SW salmon component than for the small salmon (maturing as 1SW salmon) age group.

Non-maturing 1SW salmon: The changes made to the calculations that determine pre-fishery abundance of non-maturing 1SW salmon for 1997 were continued for the determination of pre-fishery abundance in 2001. They included the addition of a new parameter to define the fraction of the Lake Melville catches that are immature and, in the absence of a commercial fishery in Labrador, the development of a raising factor to estimate 2SW returns to Labrador from a series of Labrador recruit estimates and pre-fishery abundance data from 1971–1996. A raising factor was also developed to include Labrador returns in the maturing component of pre-fishery abundance by dividing pre-fishery abundance without Labrador into pre-fishery abundance with Labrador based on the time series of Labrador recruit estimates and pre-fishery abundance data from 1971–1997. An assumed natural mortality rate [M] of 0.03 per month (see Section 4.3) is used to adjust the numbers between the salmon fisheries on the 1SW and 2SW salmon (10 months) and between the fishery on 2SW salmon and returns to the rivers (1 month)

As the pre-fishery abundance estimates for potential 2SW salmon requires estimates of returns to rivers, the most recent year for which an estimate is available is 2000. This is because pre-fishery abundance estimates for 2001 require 2SW returns to rivers in North America in the year 2002. The 2000 abundance estimates ranged between 81,470 and 169,954 salmon. The mid-point of this range (125,712) is 16% higher than the 1999 value (108,451) and is the 4th lowest in the 29-year time series (Figure 6.1.2.6). The most recent four years are shown with hollow symbols as no Labrador values were estimated for these years and the raising factor described previously was used. The results indicate an increase from the general decline in recent years but still much lower than the 917,300 in 1975. ICES is concerned that pre-fishery abundance for non-maturing salmon (Figure 6.1.2.6) still remains considerably lower than the Spawning Escapement Reserve of 212,189 pre-fishery abundance fish required to meet conservation limits in homewaters (see Section 4.4.2).

Maturing 1SW salmon: Estimation of an aggregate measure of abundance has utility for identifying trends, evaluating management measures, and investigating the influence of the marine environment on survival, distribution, and abundance of salmon. Maturing 1SW salmon are in some areas a major component of salmon stocks and measuring their abundance is thought to be important to provide measures of abundance of the entire cohort from a specific smolt class.

Similar to calculations to determine non-maturing 1SW salmon, a raising factor was also required to include Labrador returns in the maturing component of pre-fishery abundance necessitated by the closure of the commercial fishery in Labrador in 1998. Consequently, a raising factor was developed by dividing pre-fishery abundance without Labrador into pre-fishery abundance with Labrador based on the time series of Labrador recruit estimates and pre-fishery abundance data from 1971–1997. The mid-point of the range of pre-fishery abundance estimates for 2001 (376,132) is 15% higher than in 2000 (442,029) which had increased considerably from the low 1997 value of 331,815 which was the lowest estimated in the time series 1971–2001 (Figure 6.1.2.6). The reduced values observed in 1978 and 1983–84 and 1994 were followed by large increases in pre-fishery abundance.

Figure 6.1.2.5 shows the total 1SW recruits. While maturing 1SW salmon in 1998–2001 have increased over the lowest value achieved in 1997, the non-maturing portion of these cohorts remained unchanged since 1997. As the prefishery abundance of the non-maturing portion (potential 2SW salmon) has been consistently well below the Spawning Escapement Reserve (derived from S_{lim}) since 1993, this situation is considered to be very serious. The decline in recruits in the time series is alarming. Although the declining trend appears common to both maturing and non-maturing portions of the cohort, non-maturing 1SW salmon have declined further.

Egg depositions: Egg depositions in 2001 exceeded or equaled the river specific conservation limits (S_{lim} for eggs) in 30 of the 85 assessed rivers (35%) and were less than 50% of conservation in 32 other rivers (38%). Large deficiencies in egg depositions were noted in the Bay of Fundy and Atlantic coast of Nova Scotia where 6 of the 7 rivers assessed had egg depositions that were less than 50% of conservation limits. Proportionally fewer rivers in Gulf (14%) and Québec (27%) had egg depositions less than 50% of conservation. Only 57% of the Gulf rivers and 43% of the Québec rivers had egg depositions that equaled or exceeded conservation. In Newfoundland, 28% of the rivers assessed met or exceeded the conservation egg limits and 39% had egg depositions that were less than 50% of limits. The deficits occurred in the east and southwest rivers of Newfoundland (SFA 13) and in Labrador. All USA rivers had egg depositions less than 5% of conservation limits.

Smolt production: The index of smolts or juveniles from geographic regions of North America was obtained by weighting the individual river indices by the egg requirement for the salmon fishing area to which they belong (SFA_{WT}). For the index of production of interest to the forecasting of 2SW salmon abundance in the Northwest Atlantic, an alternative weighting incorporated the relative contribution to the 2SW spawner requirements of the areas or zones within North America. This allows indices of smolt production from all areas of North America to be used but attributes weights to the area indices according to the expected contribution to 2SW abundance. This suggests three levels of increasing freshwater production since 1971 (Figure 6.1.2.7). Relative freshwater production which would contribute to 2SW recruitment has been fairly stable since 1992, at about twice the level observed during the late 1970s and early 1980s.

Marine Survival: Measures of marine survival rates over time indicate that survival of North America stocks to home waters has not increased as expected as a result of fisheries changes**.** There have been no significant increasing trends in survival indices of any of the stock components since commercial closures in 1992.

6.2 Effects on US and Canadian stocks and fisheries of the quota management and closure after 1991 in Canadian commercial salmon fisheries, with special emphasis on the Newfoundland stocks

ICES previously considered the impact of the closure of the Newfoundland commercial fishery in 1992 on the Newfoundland stocks (ICES 1997/Assess:10).

Dempson *et al.* (1997) developed an index of salmon returns to illustrate the impact of the commercial salmon fishery moratorium on Newfoundland stocks. It was based on the difference between the returns prior to the moratorium (1984–1991) when there was a commercial fishery to those in the years since the commercial fishery closed (1992–1997). By averaging among rivers with counting facilities this provides an estimate of commercial fishing mortality which can be used to estimate what returns would have been if the commercial fishery had not closed. The method assumes that natural mortality during the commercial fishery years remained at the same levels on average after the commercial fishery was closed. Average commercial fishing exploitation rate was 44% on small salmon and 75% on large. These exploitation rates should be regarded as a minimum values because it is evident that the natural component of marine survival has declined in recent years.

For 2SW salmon, if the commercial fishery had remained open during this period then, on average, from 1,942 to 6,821 fewer 2SW fish would have spawned. Correspondingly, for 1SW salmon, on average, from 37,672 to 96,655 fewer 1SW salmon would have spawned. For 2SW salmon, in the years since the moratorium, spawner requirements have never been achieved if one uses the minimum estimates or have always been achieved using the maximum estimate. If the commercial fishery had not closed, then 2SW spawners would never have achieved spawning requirements even at maximum estimates.

Within Newfoundland, the commercial fishery closure has resulted in increased escapements of both small and large salmon to rivers, higher catches of large salmon (which were subsequently released) in the recreational fishery, and increased spawning escapements of both size groups. These increased spawning escapements have not however always resulted in increased smolt production. Some areas of Newfoundland, particularly the south coast, did not see increases in escapement as was expected from the closure of the commercial fishery.

6.3 Age-specific stock conservation requirements

There are no changes recommended in the 2SW salmon conservation limits (S_{lim}) from those recommended previously. Conservation limits for 2SW salmon for Canada now total 123,349 and for the USA, 29,199 for a combined total of 152,548.

6.4 Sensitivity analysis of the North American PFA analysis

ICES was asked to characterize the reliability of input data used to estimate the lagged spawner variable, with special emphasis on the Labrador region, and evaluate sensitivity of resulting pre-fishery abundance estimates (Appendix 1).

Spawner estimates are derived from a run reconstruction model described below, while the lagged spawners are calculated by applying proportions by river age to the spawner estimates and then ascribing them to the year in which their offspring will be available as 1SW non-maturing adults (pre-fishery abundance). If the run reconstruction model for Labrador is inappropriate for characterizing Labrador returns and spawners or has directional biases and/or if the river ages of Labrador salmon are biased for any reason, then lagged spawners will also be either incorrect and/or biased. In general, if the Labrador spawners are over-estimated then the forecasted pre-fishery abundance will also be over-estimated by the proportionate contribution made by the Labrador spawners to the total of Labrador, Newfoundland, Scotia-Fundy and Quebec which is then used as a variable in the forecast model (Figure 6.4.1). The contribution that Labrador spawners makes to the lagged spawner variable also increases considerably (Figure 6.4.2).

The forecast of pre-fishery abundance is highly dependent on the estimate of lagged spawners. In the present year forecast, about 12% of the forecast is determined by thermal habitat and 75% by lagged spawners. Simulations show, a varying Labrador component can in some years make a big change in pre-fishery abundance forecasts (Figure 6.4.3). Lagged spawners make an important contribution to the forecasts in 2002 and the Labrador component of lagged spawners is an important part of it. Thus, errors in the Labrador lagged spawner numbers will have a big impact on the pre-fishery abundance forecasts. As the actual number of Labrador spawners is not known, the degree of potential mis-forecasting is also unknown. This was the only technique possible for deriving lagged spawners because of a lack of an alternate data series for Labrador.

6.5 Catch options or alternative management advice with an assessment of risks

It is possible to provide catch advice for the North American Commission area for two years. The first is a revised estimate for 2001 for 2SW maturing fish based on revised estimates of the 2000 pre-fishery abundance and accounting for fish which were already removed from the cohort by fisheries in Greenland and Labrador in 2000. The second is an estimate for 2002 based on the pre-fishery abundance forecast for 2001. A consequence of these annual revisions is that the catch options for 2SW equivalents in North America may change compared to the options developed the year before.

6.5.1 Catch option for 2002 fisheries on 2SW maturing salmon

A revised forecast of the pre-fishery abundance for 2001 is provided in Table 6.5.1.1**.** This value of 332,455 is higher than the value forecast last year at this time of 295,678. A pre-fishery abundance of 332,455 in 2001 can be expressed as 2SW equivalents by considering natural mortality of 3% per month for 11 months, resulting in 239,010 2SW salmon equivalents. There have already been harvests of this cohort as 1SW non-maturing salmon in 2001 for both the Labrador (268) and Greenland (7,053) fisheries (Tables 6.5.1.2 and 6.5.1.3) for a total of 7,321 2SW salmon equivalents already harvested, when the mortality factor is considered.

6.5.2 Catch option for 2003 fisheries on 2SW maturing salmon

Most catches (91%) in North America now take place in rivers or in estuaries. The commercial fisheries are now closed and the remaining coastal food fisheries in Labrador are mainly located close to river mouths and likely harvest few salmon from other than local rivers. Fisheries are principally managed on a river-by-river basis and in areas where retention of large salmon is allowed, it is closely controlled.

Catch options which could be derived from the pre-fishery abundance forecast for 2002 (329,552 at the 50% probability level) would apply principally to North American fisheries in 2003 and hence the level of fisheries in 2002 needs to be accounted for before finalizing these catch options. Catch options were calculated by assuming probability values between 25 and 50%, accounting for mortality and the conservation limits and considering an allocation of 60% of the surplus to North America. Catches of about 6600 2SW salmon equivalents would be available at a probability value of 30%; below this probability value, there are no salmon expected to be surplus to limits. The catch at the risk neutral point (50% probability) would be about 50,600 fish. The numbers provided for catch options refer to the composite North American fisheries. As the biological objective is to have all rivers reaching their conservation requirements, river-by-river management will be necessary. On individual rivers, where spawning requirements are being achieved, there are no biological reasons to restrict the harvest.

6.5.3 Data deficiencies, monitoring needs and research requirements

Some progress was made on research needs identified last year. ICES reiterates many of last year's recommendations and suggests some further ones.

1. Estimates of total returns to Labrador no longer exist. There is a critical need to develop alternate methods to derive estimates of salmon returns and

develop habitat-based spawner requirements in Labrador.

2. There is a need to investigate changes in the biological characteristics (mean weight, sex ratio, sea-age composition) of returns to rivers, spawning stocks of Canadian and US rivers, and the harvest in food fisheries in Labrador. These data and new information on measures of habitat and stock recruitment are necessary to re-evaluate existing estimates of spawner requirements in Canada and USA and for use in the run reconstruction model.
3. Sea survival rates of wild salmon from rivers stocked with hatchery smolts should be examined to determine if hatchery return rates can be used as an index of sea survival of wild salmon elsewhere.
4. Further basic research is needed on the spatial and temporal distribution of salmon and their predators at sea to assist in explaining variability in survival rates.
5. Return estimates for the few rivers (Annapolis, Cornwallis and Gaspareau) in SFA 22 that contribute to distant fisheries should be developed and when these are available, the SFA 22 spawning requirements for these rivers (476 fish) should be included in the total.
6. A consistent approach to estimating returns is needed for instances in which offspring from broodstock are stocked back into the management area from which their parents originated.
7. Scale analysis of salmon captured at West Greenland indicated an infrequent appearance of escaped-farmed salmon. To substantiate this conclusion, farmed salmon need to be genetically characterized and included as baseline populations in continent-of-origin analysis of samples collected from West Greenland
8. The risk to stocks of being significantly above or below S_{lim} needs to be determined.

7 ATLANTIC SALMON IN THE WEST GREENLAND COMMISSION AREA

7.1 Events in the 2001 fisheries and status of stocks

7.1.1 Fishery in the WGC area

Catch, gear and effort: At its annual meeting in June 2001 NASCO introduced and agreed to a new *ad hoc* management programme for the 2001 fishery at West Greenland that incorporated the use of real-time data to allocate quota for the commercial fishery. The commercial fishery is defined as landings sold to processing plants and excludes reported private landings (not sold to plants) and unreported catch. Three harvest periods were implemented with quotas dependent on the observed average CPUE during the fishery. A total quota of 114 t was allocated for the 2001 fishery.

By regulation, all catches including landings to local markets, privately purchased salmon, and salmon caught by food fishermen, were reported on a daily basis to the Fishery Licence Office. The fishery was opened on August 13, and after closing of the agreed season of seven weeks, the reported commercial landings totalled to 34.5 t. A total of 8.0 t of private landings were reported during the 2001 season, which extended later than the closure of the commercial fishery. Compared to earlier years, a higher proportion of catch occurred in southern Greenland with 65% and 66 % taken in NAFO Division 1F in 2000 and 2001, respectively.

Licences for the salmon fishery are issued to fishermen fishing for the factories, local markets, hotels, hospitals etc., while fishing for personal use was permitted without licence for residents of Greenland. The number of active fishermen in the salmon fishery has decreased sharply since 1987, when a catch of more than 900 t was allowed and more than 500 licenses were active in the fishery. In 2001, only 76 licences were fished although this was an increase form 46 in the previous year, probably due to the expected higher quota. Of these reporting licenses, 50 licenses reported commercial landings, 23 reported private landings, and 3 licenses reported both commercial and private landings.

The average weekly CPUE varied between 90 and 161 kg per landing through the season with an overall mean of 124 kg. This was higher than any other year since 1991 apart from the record high CPUE in 2000 (343 kg).

Due to the character of this fishery, which includes provisions for personal consumption, some unreported catch likely occurs. Unreported catch is primarily associated with personal consumption or subsistence fishing, which appears to have remained relatively stable through time. There is presently no quantitative approach for estimating the magnitude of unreported catch; however, it may still be at the same level as proposed for recent years (around 10 t).

Origin of catches:

In total, 67.5% (388) of the salmon sampled from the 2001 fishery were of North American (NA) origin and 32.5% (187) fish were determined to be of European origin. Applying the results of the above analysis to the reported catch indicated that 27.2 t (9,849 salmon) of North American origin and 15.4 t (5,389 salmon) of European origin were landed in West Greenland in 2001. Quota reductions have resulted in an overall reduction in the numbers of both North American and European salmon landed at West Greenland until 1999. The number of North American salmon remained about the same in 1999 and 2000 (5,000-6,000 salmon), but doubled in 2001. The number of landed salmon of European origin increased in 2000 due to a higher proportion of European salmon in the Division 1F where a higher proportion was again observed in 2001.

Biological characteristics of the catch: The general downward trend in mean length and weight (unadjusted for sampling date) of both European and North American 1SW salmon observed from 1969 to 1995 reversed in 1996 when mean lengths and weights increased. From 1996 to 1998 the mean lengths and weights were relatively stable but increased significantly in 1999. In 2000, a decrease was observed, mainly in the North American component where the mean lengths and weights were among the lowest observed in the time series. In 2001, mean lengths and mean weights increased again to a level close to the overall average for the recent decade.

The proportion of the European origin salmon that were river age 1 fish has been quite variable through the later years with relatively high values in 1998-2000, the 2000 value being the highest on record. In 2001 this proportion was close to the overall mean value. A high proportion of this group suggests a high contribution from Southern European stocks. In 1998 and 1999 low percentages of 7.6% and 7.2%, respectively, of river age 3 were observed, the lowest on record. An increase from 1999 to 2001 (to 26.1%) was observed, higher than the overall mean of 16.8% and among the highest in the data series. The percentage of river age 2 salmon of North American origin declined somewhat from 1998, which was close to the overall mean value of 34.0%, to 22.6% in 2001.

The sea-age composition of the samples collected from the West Greenland fishery showed no significant changes in the proportions in the North American component of fish from 1998 to 2001. The proportion of 1SW salmon in the European component has been very high since 1997 (99.3 %), and was in 1999 and 2000 estimated at 100 %. A low proportion of 2SW fish and previous spawners (both components were 1.1 %) was observed in 2001.

7.1.2 Evaluation of the ad hoc management system implemented in 2001

At its 2001 meeting, NASCO implemented an ad hoc management program that provided for in-season adjustments to the allocated quota based on real time observation of catch per unit effort (CPUE) in the fishery at West Greenland (NASCO 2001). The program was based on an apparent relationship between annual catch per unit effort estimates for the West Greenland fishery and pre-fishery abundance (PFA) estimates for the North American stock complex (Figure 7.1.2.1, top panel). ICES noted that there is also an apparent relationship for the Southern European stock complex (Figure 7.1.2.1, middle panel). The management system allocated an initial quota corresponding to a 25% probability level from the quota options table (28 t) during an initial harvest period of 7 days. At the end of the first harvest period (7 days), CPUE during the harvest period was assessed to determine if the fishery would remain open and the levels of additional quota to be allocated. At the end of the 2nd harvest period, aggregate CPUE over the first two harvest periods was assessed leading to a second and final decision regarding fishery closure and quota allocation.

CPUE thresholds for management decision points in the program were established based on CPUE levels associated with specific probability forecasts of 2001 PFA. There is an implicit assumption that CPUE during the harvest period considered accurately reflects the overall PFA level. The threshold level between the low and medium CPUE levels was established based on the CPUE associated with the 25% probability estimate of PFA (187,700 salmon in 2001). The CPUE level associated with this PFA forecast was estimated by regressing CPUE against PFA (1987 to 1992 and 1995 to 1999), using the resulting equation with an input of 187,700 salmon in 2001 to estimate a CPUE level of approximately 100 kg/day (Figure 7.1.2.2, top panel). The threshold level between the medium and high CPUE levels was established based on the CPUE associated with the 50% probability estimate of PFA (295,678 salmon in 2001). Similarly, the regression equation was used to estimate the CPUE associated with this PFA as approximately 135 kg/day (Figure 7.1.2.2, top panel).

The rationale associated with using the 25% and 50% PFA levels was that the fishery would be closed if CPUE data indicated that the actual PFA was below 187,700 (CPUE < 100 kg/day), and conversely, the quota associated with the 50% probability level of the PFA forecast should not be fully allocated unless CPUE provided confirmatory information that the PFA exceeded 295,678 salmon (CPUE > 135 kg/day).

During the 2001 commercial fishery, the aggregate CPUE remained at a medium level (between 100 and 135 kg/landing) at both decision points (Figure 7.1.2.3) and a total quota of 114 t (the average of the quotas indicated by the 25% and 50% risk levels) was allocated. Decisions regarding the length of harvest periods and decision points were not critical during implementation of the management system during 2001 given the NASCO established CPUE thresholds of 100 and 135 kg/landing, because CPUE levels remained intermediate to these two thresholds following the 2nd day of the season (Figure 7.1.2.3). Of the allocated quota, only 34.5 t (30.3%) was actually landed by the commercial fishery.

ICES examined the robustness of CPUE data used at decision points to make quota allocation decisions during the fishery. Although CPUE aggregated on an annual basis is available from 1987 to 1992 and 1995 to 2001, CPUE data on a daily trip basis were only available from 1997 to 2001. These data included date, port landed, NAFO Division, fisher name and/or license and landed and live weight of salmon caught. Trip information was only available for commercial trips that landed and reported salmon. Information on commercial trips that targeted, but did not land or report landing salmon are not available. Other information that could be used to characterize fishing effort including vessel size, gear type, amount of gear deployed, soak time and other trip information are unavailable for historical data.

Examination of Spatial and Temporal Variability in Fishing Effort

The number of trips reporting commercial landings of Atlantic salmon was used to estimate commercial fishing effort. However, trips that did not land salmon could not be quantified. The number of trips reporting commercial landings of Atlantic salmon ranged from 712 trips (1997) to 58 trips in 2000 (Table 7.1.2.1). Distribution of trips across NAFO Divisions and weeks has been variable through time, and number of trips landing within given weeks is often very low, as observed during the 1998 and 1999 fisheries. The proportion of effort within Greenland was not constant among NAFO Divisions over the period 1997 to 2001 (Figure 7.1.2.4). The relative instability of fishing effort across area and time may introduce biases in CPUE estimates. In other fisheries, effort standardization procedures (e.g., General Linear Modelling approaches) have been applied to standardize effort relative to week, area, vessel size, etc., but the low number of trips within cells and lack of information about trips, vessels and gear precludes the application of many standardization approaches to existing data.

Patterns in CPUE

The CPUE data presented is slightly slightly different from data provided at the 2001 NASCO meeting, and was updated to include currently available estimates of PFA and CPUE data. Commercial CPUE over the course of the entire season seems to correspond to general trends in the North American PFA estimate for the period 1986 to 2001 (Figures 7.1.2.1 top panel and 7.1.2.5), with the exception of a large outlier in the 2000 when CPUE was much higher than the apparent prefishery abundance of the resource. In addition, there appears to be a significant relationship between annual commercial CPUE and trends in the Southern European PFA estimate for the period 1986 to 2001 (Figure 7.1.2.1 top panel), with the same outlying point in 2000. However, residual patterns for both relationships are non-random, with blocks of positive residuals preceding the 1993 and 1994 fishery buyout, and a block of negative residuals after this period. This residual pattern may indicate changes in the relative efficiency of the fishery following the buyout resulting in higher CPUE levels during the post-1994 period when overall effort levels were lower. The residual pattern is of particular concern because the apparent relationship between CPUE and PFA may not be valid, particularly for associating current and future CPUE with higher levels of abundance that were generally observed before 1993.

Catch levels in the fishery from 1997 to 2001 were skewed toward lower catches, with trips landing less than 100 kg representing 60% to 80% of all trips landed (Figure 7.1.2.6). Since fishers do not report information on trips taken, no effort data are available for trips that targeted but did not land salmon (zero catches). The absence of zero catch trips in the time series may represent a bias leading to an overestimation of actual CPUE, particularly during periods of low abundance. If the proportion of zero catch trips increased during periods of lower abundance, this would tend to change the shape of the relationship between CPUE and PFA in this region, possibly producing non-linearity. Higher proportion of trips reporting landings in excess of 100 kg in 2000 and 2001 may reflect higher levels of availability or abundance since 1999 (Figure 7.1.2.6).

The ad Hoc Management Program assumes a relationship between PFA and CPUE over a period as short as 5 to 7 days prompting a need to examine CPUE on a finer temporal scale than an annual basis. On a weekly basis, CPUE was relatively stable and at low levels in 1997 and 1998, but was more variable among weeks from 1999 and 2001 (Table 7.1.2.2). Exceptionally high CPUE levels (343 kg/landing) were observed during the first week of the 2000 fishery, more than 2.5-fold higher than levels observed during the corresponding week in 1997, 1998, 1999, and 2001. In addition, when CPUE aggregated over the harvest periods utilized, is compared to prefishery abundance estimates, there is considerably less correspondence with PFA trends observed over the past five years (Figure 7.1.2.7), although there is little contrast in the levels of both PFA and CPUE between 1997 and 1999.

Given issues of variability of effort and CPUE levels among weeks and NAFO Divisions, unstandardized catch per unit effort data should only be used with extreme caution relative to in-season quota allocation decisions. If this framework is used to manage the West Greenland fishery in the future, decision thresholds (CPUE levels delineating low, medium, and high abundance zones) and quota allocation levels will need to be updated annually to reflect changes in PFA forecasts and levels of precaution utilized to identify ranges in quota levels allocated at in-season decision points (Figure 7.1.2.2, bottom panel).

Concerns about CPUE Thresholds

The relation between CPUE and PFA (Figure 7.1.2.1) suggests that relatively small changes in CPUE levels are associated with large changes in PFA (e.g., a 50 kilo increase in CPUE relates to an increase of approximately 150,000 PFA salmon). This indicates that both the CPUE thresholds and in-season measures of CPUE must be accurately estimated to provide useful information relative to abundance. ICES notes that CPUE thresholds were established based on 25% and 50% probability levels associated with PFA forecasts, and recommends that if future adaptive management frameworks are developed, decision thresholds should be established based on more precautionary probability levels, consistent with limit reference points (S_{lim}).

Despite concerns about the use of CPUE data as a source of confirmatory information for abundance estimates, ICES agrees with endorses the general principle of using informative in-season measures of abundance to adaptively manage fisheries. Development of more refined data characterizing fishing effort (e.g., vessel size, gear type, amount of gear deployed, soak time, documentation of zero landings trips and private sales trips) would allow for detailed analyses of CPUE data to characterize availability of Atlantic salmon in West Greenland.

7.1.3 Status of stocks in the WGC area

The salmon caught in the West Greenland fishery are mostly (>90%) non-maturing 1SW salmon, many of which would return to home waters in Europe or North America as MSW fish if they survived the fishery. While non-maturing 1SW salmon make up more than 90% of the catch there are also 2SW salmon and repeat spawners including salmon that had originally spawned for the first time after 1-sea-winter. The most abundant European stocks in West Greenland are thought to originate from the UK and Ireland although low numbers may originate from northern European rivers. Most MSW stocks with the exception of Newfoundland are thought to contribute to the fishery at West Greenland. Status of relevant stocks in the NEAC and NAC areas are summarized below.

Southern European Stocks:

The main contributor to the abundance of the European component of the West Greenland stock complex is non-maturing 1SW salmon from the southern areas of Europe. A Run-Reconstruction Model was used to update the estimates of pre-fishery abundance of non-maturing 1SW salmon. MSW salmon stocks in the Southern NEAC area show a consistent decline over the past 10–15 years, and recent spawning escapement has been below conservation limits ($\mathbf{S_{lim}}$). In summary:

- the proportion of European fish in catches at West Greenland decreased steadily during the 1990s reaching levels of 10% to 15% in recent years.
- marine survivals of wild and hatchery-reared smolts in Southern NEAC area show a constant decline over the past 10-20 years.
- MSW returns and spawning stocks in the Southern NEAC area derived from the NEAC PFA model show a consistent decline over the past 20 to 30 years.
- consistent trends in marine survival of smolts and the estimated returns and spawners as derived from the PFA model suggest that returns are strongly influenced by factors in the marine environment
- overall spawning escapement has fallen below the conservation limit in four of the past five years

North American Stocks:

The North American Run-Reconstruction Model was used to update the estimates of pre-fishery abundance of non-maturing and maturing 1SW salmon from 1971-2000. The 1998 estimate of pre-fishery abundance of non-maturing 1SW salmon was the lowest on record and continued a decline that began in 1979. A slight increase is indicated for the period 1998-2000. In addition to the steady decline in total recruits (both maturing and non-maturing 1SW salmon) over the last ten years, maturing 1SW salmon (grilse) have become an increasingly large percentage of the North American stock complex. This percentage has risen from about 45 % at the beginning of the 1970s, to around 70 % in 1992–95 and almost 80 % in 1997. 2SW returns have declined from a peak of 121,000 in 1980 to 58,000 in 2001. The percentage of North American salmon in the West Greenland catch increased steadily from 50% to 60% in the early 1990s to approximately 90% by 1997 and declined to approximately 66% in 2000 and 2001.

Newfoundland:

- 2SW and MSW salmon are a relatively small component of this stock complex
- 2SW returns 6th highest in a 31 year time series
- 2SW spawners in 2001 at approximately twice 2SW stock conservation limits

Labrador:

- 2SW returns peaked in 1995, and decreased again in 1996 and 1997
- no estimate is given since 1997 from this area, there being no commercial fishery, which was the basis for the return and spawner model for Labrador

Quebec:

- 2SW salmon are an important part of this stock complex
- 2SW returns 3rd lowest in a 31 year time series
- 2SW spawners in 2001 at 71% of 2SW conservation limit ($\mathbf{S}_{lim}$)

Gulf of St. Lawrence:

- 2SW salmon are an important part of this stock complex
- 2SW returns 5th lowest in a 31 year time series
- 2SW spawners in 2001 at 77% of 2SW conservation limit ($\mathbf{S}_{lim}$)

Scotia-Fundy:

- 2SW returns 3rd lowest in a 31 year time series
- 2SW spawners in 2001 at 19% of 2SW conservation limit (**S**$_{lim}$)
- inner Bay of Fundy stocks listed as Endangered, some of which may have contributed to the fishery at West Greenland

United States:

- 2SW returns 2nd lowest in a 31 year time series
- 2SW returns in 2001 at 3% of 2SW conservation limit (**S**$_{lim}$)
- stocks in two of three regions extirpated, 8 remaining rivers listed as Endangered

Despite some improvements in the annual returns to some rivers, both in European and North American areas, the overall status of stocks contributing to the West Greenland fishery remains poor, and as a result, the status of stocks within the West Greenland area is thought to be low compared to historical levels.

7.1.4 Changes in the continent of origin of salmon captured at West Greenland including changes in migration patterns

There has been a considerable increase in proportion of North American origin salmon in the fishery at West Greenland in recent years. The proportion has changed dramatically over the period of observation, 1969-2001, from below 40 % to 90 %, with the highest proportion of North American salmon observed in 1999; the proportion declined in 2001. In order to more completely describe the historical and current temporal and spatial distribution of North American and European salmon at Greenland, five years (1987, 1990, 1992, 1997, and 2001) were arbitrarily chosen and the catch patterns are displayed in Figure 7.1.4.1 to show the variability in landings by week and NAFO Division. In several years, the highest landings occurred in weeks 33 to 38 and were distributed along the coast from NAFO Division 1A to 1F. However, in both 1992 and 2001 higher proportions of the overall landings occurred in NAFO Division 1F compared with all other divisions. In 1990 and 1992, higher proportions of the landings were distributed over more weeks than in the other years. Since landings varied both spatially and temporally, further analyses considered the catch to more completely describe temporal and spatial distribution of North American and European salmon. This was done through general linear models using catch to weight the results.

Application of General Linear Models to Catch Data

The biological explanation(s) for the changes in North American and European salmon will continue to elude us due to incomplete knowledge of migration of the various components contributing to the West Greenland fishery and, more importantly, the relative contributions of various stock groupings. Previous tagging studies, including tagging at West Greenland, had shown that the southern European stock group contributed more heavily to Greenland than did the northern group. Within North America, it has been shown that stocks in the Gulf of St. Lawrence contributed more heavily than others to Greenland. The DNA analysis of salmon captured at West Greenland that started in 2000 has shown that annual variations in proportional contributions do occur (ICES/ACFM15), and should lead to a greater understanding of the mixed stock fishery.

The North American proportions were analysed from 1987 to 1999. The year 2000 samples were not included because of the short time scale and geographical distribution of the catch and the results from the 2001 samples are not yet fully available.

Analysis of Variance for North American proportion at West Greenland

The North American proportion varies over year, between NAFO Divisions and there is a significant interaction effect between year and the various NAFO Divisions. The North American proportion increased from NAFO Division 1A to 1C then declined from 1D to 1E and 1F (Figure 7.1.4.2). The North American proportion has increased significantly from 1987 to 1999 (Figure 7.1.4.3). The reasons for the varying North American proportions among NAFO Divisions and years are not known. However, this possibly reflects different migration patterns and time of arrival at Greenland of the various stock components as well as a highly variable fishery.

Analysis of Microtag Recoveries

The recovery of tagged salmon within the West Greenland fishery provided an additional option for investigating fish distribution patterns. Details of all the batches of tagged fish have been collated and reported annually to ICES.

Microtags were recovered at West Greenland from 1985 to 1992. The fishery was closed in 1993 and 1994, and very few tags have been recovered since 1995. Overall, 631 microtags were recovered at West Greenland in the period 1985 to 1992 (Table 7.1.4.1). Numbers of tag recoveries are not sufficient to allow comparison of individual stocks or national stock groupings (tags from 7 countries and over 60 stocks), but do enable comparison between continent of origin (North America 407 tags and Europe 224 tags). Aggregated over all years the proportions of tags from North American countries and Europe recovered in each of the NAFO Divisions at West Greenland seem broadly similar. However, this does not account for differences in the relative size of the tagged groups at large.

Over the period, 1985 to 1991, European countries released around 4.7 million microtagged fish between 1985 and 1991, of which 4% were wild. North American countries released 4.4 million microtagged fish over the same period, with 1% wild. Although 51% of the tagged fish at large during the time period were European, only 35.5% of the recoveries were of European origin. Thus North American tagged salmon were captured in significantly higher proportion than their proportion in the tagged population at large. Recoveries were scaled by dividing counts by 100,000 tags released in the previous year. In addition, recoveries were corrected for the scanning effort using a raising factor based on the scanned proportion of the catch for each NAFO Division and sampling week. This had the effect of making tag recoveries proportional to the landings.

The analysis of the proportions of North American tagged stocks in the catch was strongly influenced by year. This was, in part at least, thought to reflect scanning programs, because scanning did not occur in all divisions (i.e., catches in 1A were not sampled at all, sampling in 1C only occurred in 1990 to 1992, and 1F was not sampled from 1989 to 1991). For the seven years and five divisions where a comparative analysis was possible, 13 combinations had no sampling (Figure 7.1.4.4). The fishery also shifted over time within seasons. By constraining the analysis to standard weeks 33 to 35, there were only six of 21 weeks without tag recoveries from 1986 to 2001. The annual variation in sampling for tags precluded modelling the data over the entire time and space array. However, to attempt to describe the distribution of fish from each of the continents (North America and Europe), the total tag returns for each were plotted over the selected NAFO Divisions and standard weeks (Figure 7.1.4.4). These plots describe the pattern in the fishery within the period, but do not highlight any major differences in distribution between the continents of origin as only relatively small differences were noted. For both groups, Division 1D appeared to be significant in terms of the probability of recapture.

The key points of the above assessments indicate that:

- The proportion of North American fish recovered at West Greenland has significantly increased from 1987 to 1999.
- North American tagged fish have been more vulnerable to capture in the fishery than European fish; based primarily on hatchery fish.
- The fact that the fishery has not been stable annually in either time (standard week) or space (NAFO Division) precludes evaluating general migratory patterns, let alone patterns for different stocks.

7.2 Effects on European and North American stocks of the West Greenland management measures since 1993

There have been the following significant changes in the management regime at West Greenland since 1993:

1) NASCO adopted a new management model (Anon., 1993) based upon ICES' assessment of the PFA of non-maturing 1SW North American salmon and the spawner escapement requirements for these stocks. This resulted in a substantial reduction in the TAC agreed to by NASCO from 840 t in 1991 to 258 t in 1992, and further reductions in subsequent years.

2) The next change in management was the suspension of fishing in 1993 and 1994 following the agreement of compensation payments by the North Atlantic Salmon Fund. Due to the closure of the fishery in the two years no sampling could be carried out in Greenland, and no biological data were collected.

3) In 1995 and 1997, established quotas were substantially lower than quotas established before 1993. In 1996, NASCO failed to reach an agreement and Greenland unilaterally established a quota of 174 t.

4) In 1998, NASCO agreed on a subsistence fishery of 20 t, which in the past has been estimated for internal consumption at Greenland. In 1999, a multi-year management plan was agreed restricting the annual catch to that amount used for internal consumption.

5) An *ad hoc* management arrangement for 2001 was agreed by NASCO, implementing an adaptive quota calculation, based upon three harvest periods. The resulting total quota for all harvest periods was 114 t.

The estimated numbers of salmon returning to home waters in the absence of a fishery, 1993–1994, or had the fishery in 1995–2001 not taken place are:

Year	Quota T	Catch t	EU Fish	NA Fish
1993	89	0	10154	12324
1994	137	0	15630	18970
1995	77	83	6926	16520
1996	174	92	5927	16589
1997	57	58	3031	12771
1998	20	11	597	2244
1999	20	19	405	4013
2000	20	21	1887	3988
2001	114	43	3492	7346

The potential catches in the years 1993 and 1994 of 89 and 137 t, respectively correspond to the TACs calculated in accordance with the quota allocation computation model that was agreed by NASCO at its annual meeting in 1993. For the successive years nominal catch figures are used. The table above shows the number of salmon returning to home waters provided there was no catch in Greenland. From 1993 to 2001, the mean number of potentially returning fish per tonne caught at Greenland is calculated as 171 and 87 salmon for North America and Europe, respectively.

From 1972 to 1992 exploitation rates in Greenland of the North American component of the salmon stock fluctuated between 10% and 45 % around an average of 34 % (Figure 7.2.1). The management measures in force since 1993 resulted in an average exploitation rate of this component of 13 %, for the period 1995 to 1997, about one third of its previous level after reopening of the fishery in 1995. After the 1998 agreement the exploitation rates decreased to about 5 %.

In the current analysis the effects of the management measures taken at West Greenland have been examined in terms of numbers of fish only. Thus it has been difficult to show direct benefits to home-water stocks from these measures.

7.3 Age-specific stock conservation limits for all stocks occurring in the WGC area

Sampling of the fishery at West Greenland since 1985 has shown that both European and North American stocks harvested are primarily (greater than 90%) 1SW non-maturing salmon that would mature as either 2 or 3 SW salmon, if surviving to spawn. Usually less than 3% of the harvest is composed of salmon that have previously spawned and a few percent are 2 SW salmon that would mature as 3SW or older salmon. For this reason, conservation limits defined previously for North American stocks have been limited to this cohort (2SW salmon on their return to homewaters) that may have been at Greenland as 1SW non-maturing fish. These numbers have been documented previously by ICES and are shown in Section 7.4.

Conservation limits for the NEAC area have been split into 1SW and MSW components on the basis of the average age composition of catches in the past ten years. The stocks have also been partitioned into northern and southern stock complexes, and tagging information and biological sampling indicates that the majority of the European salmon caught at West Greenland originate from the southern stock complex. The current conservation limit estimate for southern European MSW stocks is approximately 260,000 fish (Section 2). There is still considerable uncertainty in the conservation limits for European stocks. Outputs from the national PFA model are only designed to provide a guide to the status of stocks in the NEAC area. It has been noted that the conservation limit estimates may change from year to year as the input of new data affects the 'quasi-stock-recruitment relationship'. Previously, the conservation limits for MSW salmon in the NEAC area have not been incorporated into the modelling of catch options for West Greenland.

7.4 Catch options or alternative management advice with an assessment of risks

7.4.1 Overview of provision of catch advice

Although advances have been made in our understanding of the population dynamics of Atlantic salmon and the exploitation occurring in the fisheries, the concerns about the implications of applying TACs to mixed-stock fisheries are of concern. In principle, adjustments to catches in mixed-stock fisheries provided by means of an annually adjusted TAC would reduce mortality on the contributing populations. However, benefits losses to particular stocks would be difficult to demonstrate, in the same way that damage to individual stocks are difficult to identify.

Models based on thermal habitat in the northwest Atlantic and spawning stock indices to forecast pre-fishery abundance have been used to provide catch advice for the West Greenland fishery. While the approach has been consistent since 1993, the models themselves have varied slightly over the years. Changes have been made to these models in attempts to improve their predictive capabilities and add more biological reality. In particular, the models since 1996 have used a spawning stock surrogate variable (lagged spawners) in an attempt to describe the variations in parental stock size of the non-maturing 1SW component (PFA). The models of previous years included the following predictor variables: 1993 - thermal habitat in March; 1994 - thermal habitat in March; 1995 -thermal habitat in January, February, and March; and 1996–2001 - thermal habitat in February and lagged spawners from the Labrador, Newfoundland, Québec, and Scotia-Fundy regions of Canada. In 2000–2001, the model was based on the natural log of PFA relative to the natural log of spawners and habitat variables. In this way, the survival rate of salmon (PFA / Spawners) has a mean survival level that is modified by the habitat environmental variable.

As the method of estimating spawning escapement for Labrador was based on commercial catches and exploitation rates, which ended in 1997; lagged spawner values will have missing components in year 2003. Thus, an alternative index of salmon abundance will be required in the future. Preliminary investigations into the development of a juvenile abundance index as an alternative index of salmon abundance was continued.

North American run-reconstruction model The North American run-reconstruction model has been used to estimate pre-fishery abundance of 1SW non-maturing and maturing 2SW fish adjusted by natural mortality to the time prior to the West Greenland fishery

(See Section 3). Estimates of 2SW returns prior to 1998 in Labrador are derived from estimated 2SW catches in the fishery using a range of assumptions regarding exploitation rates and origin of the catch. With the closure of the Labrador fishery, 1998 to 2000 returns were estimated as a proportion of the total for other areas based on historical data..

Update of thermal habitat: Thermal habitat has been updated to include 2001 and January and February 2002 year data. Two periods of decline in the available habitat are identified (1980 to 1984 and 1988 to 1995) in the February index (Table 7.4.1.1 and Figure 7.4.1.1). Available habitat for February increased (10%) in 2002 from 1,685 to 1,865. The 2002 February value is more than 10% higher than the long-term mean of 1,661.

Update of lagged spawners: The lagged spawner variable used in the model is an estimate of the 2SW parental stock of the PFA. Previous analyses indicated that the sum of lagged spawner components from Labrador, Newfoundland, Québec, and Scotia-Fundy and excluding Gulf and U.S. was the strongest explanatory variable for the model. Inclusion of the Gulf spawning component reduced the explanatory power of the variable. It is recognized that there are problems inherent in this variable. The exclusion of a major component of the spawning stock contributing to the PFA was less than satisfactory. As well, spawning escapement estimates for Labrador are not available for the years 1998–2001. The previously formulated lagged spawner variable will therefore not be available beyond 2002. Alternatives to the lagged spawner variable are being explored.

Forecast model for pre-fishery abundance of North American 2SW salmon

North American Forecast Model: The 2002 forecast of pre-fishery abundance was based on a modelling approach where habitat acts on PFA through survival rather than on absolute abundance.

In the case of the PFA model, the survival rate of salmon (PFA / Spawners) has a mean survival level that is modified by the habitat variable. A linear form of the model fits the natural log of PFA relative to the natural log of spawners and habitat variables.

The basis for the model is the same two predictor variables as were used from 1999 to 2001: thermal habitat for February (term H2) and lagged spawners (sum of lagged spawners from Labrador, Newfoundland, Scotia-Fundy and Quebec, term SLNQ) (ICES 1996/Assess:11). This was justified on the basis of studies showing that salmon stocks over wide geographic areas tend to have synchronous survival rates and that the winter period may be the critical stage for post-smolt survival and maturation (Scarnecchia 1989; Reddin and Shearer 1987; Friedland *et al.* 1993; Friedland *et al.* 1998). Consequently, the model used in 2001 was updated to reflect the inclusion of the additional value and the refinement of other parameters to the time series of pre-fishery abundance estimates.

There was a significant linear relationship between estimated and predicted values of pre-fishery abundance versus February thermal habitat and lagged spawners (SLNQ) (log transformed model: $F_{2,18} = 66.41$; $r^2 = 0.87$). All model parameters were significant at less than the 5% level. Individually, the two predictor variables are also significantly related to pre-fishery abundance. Similar to last year, February habitat accounted for 12% of the total sum of squares and SLNQ spawners accounted for 75%. The jackknife and simulated predicted values for pre-fishery abundance for 1978 to 2002 are shown in Table 7.4.1.1 and Figure 7.4.1.2. The predicted values fit the observed data quite well except in the late 1980s and 90s when abundance was low and there are small positive residuals at the end of the time series (Figure 7.4.1.1). Also the residual in 2000 is one of the highest in the time series. This may indicate a developing trend to negative residuals meaning that pre-fishery abundance will be over-forecasted. The predicted pre-fishery abundance for 2002 using the February thermal habitat and lagged spawner model is about 329,600 at the 50% probability level (Table 7.4.1.1).

Predictions continue to be influenced primarily by the spawning stock variable. Thus, low levels of spawning stocks would modify the predictions of pre-fishery abundance during periods of high levels of habitat. During 1998 and 1999 thermal habitat has increased considerably, but the predicted pre-fishery abundance has remained low due to the large decline in spawners (Figure 7.4.1.1). However, the estimated 2SW spawners have improved in the year 2002, resulting in an increase of forecasted pre-fishery abundance.

Using the current model to estimate the 2001 pre-fishery abundance yields a value of 332,455. Note that the previously reported values of pre-fishery abundance were based on natural mortality rates of M=0.01 were revised to M=0.03 and thus previously reported values of pre-fishery abundance cannot be compared to those reported herein this report. The inclusion of errors in the lagged spawners has been shown to increase the median value and to widen the distribution of the forecast (ICES CM 2000/ACFM:13). Also due to the time lag between forecasted and estimated prefishery abundance there is a delay of two years before comparison of estimated and forecasted values can be made. Consequently, any developing trend in high positive or negative residuals indicating a poor fit to recent data will be hard to detect until after the fishery.

Southern European Forecast Model: The development of a preliminary model to forecast the prefishery abundance of non-maturing (potential MSW) salmon from the Southern European stock group is discussed in Section 5. Stocks in this group are the main European contributors to the West Greenland fishery.

The proposed model is similar to the North American model.

The data used in the model (Table 7.4.1.2) consisted of:

- PFA: the pre-fishery abundance of MSW salmon from Southern Europe for the period 1977 to 2000 taken from the output of NEAC PFA model as reported in Section 2;
- Stock: the index used in the model is the 'lagged egg' numbers for the period 1977–2002 derived from the national PFA and CL analysis;
- Habitat: the same habitat index was used as in the North American PFA prediction model. (Table 7.4.1.1).

The prefishery abundance forecast in 2002 for Southern European MSW stock will decline to approximately 552,000. This is about one third of the estimated PFA in the mid 1970s, and lower PFA levels have only been estimated for three other years (1996 to 1998). The probability distribution of the 2002 forecast is shown in Section 2 (Table 5.3.1). Although the model is not strongly driven by Year this decline is consistent with the continuing decline in estimated lagged egg deposition (egg numbers) in Southern European stocks.

Stochastic Analyses for North American PFA

Although the exact error bounds for the estimates of prefishery abundance (NN1(i)) are unknown, minimum and maximum values of component catch and return estimates have been estimated. Simulation methods were used to generate the probability density function of NN1(i). These estimates will be used to develop risk analysis and catch advice presented in Section 7.4.2. to 7.4.3. Managers may use this information to determine the relative risks borne by the stock (i.e., not meeting spawning limits S_{lim}) versus the fishery (e.g., reduced short-term catches).

7.4.2 Development of catch options for 2002

Catch advice for 2002: The fishery allocation for West Greenland is for fisheries on 1SW salmon in 2002, whereas the allocation for North America can be harvested in fisheries on 1SW salmon in 2002 and/or in fisheries on 2SW salmon in 2003. To achieve spawner limits, a pool of fish must be set aside prior to fishery allocation in order to meet spawner limits and allow for natural mortality in the intervening months between the fishery and return to river. In 2000, the spawner limit for North America was 152,548 2SW fish. Thus, 212,189 pre-fishery abundance fish must be reserved ($152{,}548/\exp^{(-.03*11)}$) to equate to inriver S_{lim} because of natural mortality between Greenland and Canada. The difference between the value reported in last year's report of 170,286 is entirely due to the change in a natural mortality rate of 0.03 per month from 0.01 per month previously used.

Quota computation for the 2002 fishery requires an estimate of pre-fishery abundance [NN1], stock composition by continent [PropNA], mean weights of North American and European 1SW salmon [WT1SWNA and WT1SWE, respectively], and a correction factor for the expected sea-age composition of the total landings [ACF]. Exponentially smoothed values of the biological characteristics were based on the previous years (1996–1999) and those collected during the 2001sampling programme (Table 7.4.2.1).

The quota values based on this forecast between interquartile limits of the probability density function from Table 7.4.1.3 are in Table 7.4.2.1. At the sharing fraction (Fna) of 0.4 allocation to West Greenland, quota options range from 0 to 167 t.

7.4.3 Risk assessment of catch options

The provision of catch advice in a risk framework involves incorporating the uncertainty in all the factors used to develop the catch options. The ranges in the uncertainties of all the factors will result in assessments of differing levels of precision. The analysis of risk involves four steps: 1) identifying the sources of uncertainty; 2) describing the precision or imprecision of the assessment; 3) defining a management strategy; and 4) evaluating the probability of an event (either desirable or undesirable) resulting from the fishery action. The management of Atlantic salmon in the North American and Greenland Commission areas involves managing for a fixed escapement of salmon to rivers in North America. The conservation requirements to North America are considered to be a limit reference point. The undesirable event to be assessed is that the spawning escapement after fisheries will be below the conservation limit.

The risk analysis of catch options for Atlantic salmon from North America incorporates the following input parameter uncertainties:

1. the uncertainty in the conservation requirement,

2. the uncertainty of the pre-fishery abundance forecast, and

3. the uncertainty in the biological parameters used to translate catches (weight) into numbers of North American origin salmon.

North America is divided into six stock areas that correspond to the areas used to estimate returns and spawning escapements. Under the assumption of equal production from all stock areas (i.e., recruitment in direct proportion to the spawner requirement) just over 172,000 fish should escape to North America as spawners to achieve the spawner requirement in all six stock areas at a 50% probability level. This value is higher than the point estimate for the North American stock complex (152,548 2SW salmon) because it includes the annual variation in proportion female and the objective to have sufficient escapement in six stock areas simultaneously.

Last year, ICES expressed concerns that the spawning requirement presently used for North America is for the continent as a whole and does not reflect the expected returns to the six regions, i.e., even if 172,000 2SW salmon reach the coast of North America, there will be severe under escapement in some regions. Specifically, the 2SW returns to Labrador, Scotia-Fundy and USA have been below their corresponding conservation limits since 1985. Between 1992 and 1997, the most recent years when estimates are available for all regions of North America, Quebec and Gulf regions have accounted for a disproportionate number of salmon relative to their 2SW requirements, (Figure 7.4.3.1)

Based on past performance, there is no reason to expect the abundance of salmon in the North Atlantic to be proportional to the regional 2SW spawner requirements. Assuming that the abundance of Atlantic salmon in 2002 will be proportional to the lagged spawners that would have contributed to the prefishery abundance, we can calculate the number of salmon required to return to North America to achieve region-specific conservation requirements. To achieve the Newfoundland 2SW requirement, just over 41,000 2SW in theory would be required to return to North America. In the regions with lower stock performance, returns to North America of about 441,000 fish would be required for the Scotia-Fundy region and returns to North America of more than 1.5 million fish would be required for achieving the USA conservation requirements (Table 7.4.3.1).

There is a zero chance that the returns to USA rivers will be anywhere near 29,000 2SW salmon in 2003. There is little chance of returns in 2003 being sufficient to meet the Scotia-Fundy requirement even in the absence of high seas fisheries. The other four regions could meet conservation requirements based on the realized returns in recent years and the anticipated PFA of salmon in 2002 (Table 7.4.3.1).

To provide a better guide to managers, an alternative risk analysis is proposed. ICES recommends that fisheries managers attempt to meet the conservation limits simultaneously in the four northern regions of North America: Labrador, Newfoundland, Quebec, and Gulf. For the two southern regions, Scotia-Fundy and USA, an alternate objective to that of achieving the conservation requirement would be to rebuild the stocks, i.e., assess fisheries relative to the objective of achieving minimally a pre-agreed increase in returns relative to the realized returns of a previous time. Rates of increase could be as low as a 10% annual increase relative to the stock levels observed in the previous five years for those stocks that are approaching a stock status objective. More aggressive rebuilding rates such as 25% per year could be used for stocks that are very far from their desired state. Both levels of rebuilding are quantified in the following risk analysis.

Model fitting and the confidence intervals for the pre-fishery abundance of non-maturing North American origin salmon are described in Section 7.4. The required elements for the risk analysis are the distributions of pre-fishery abundance and their associated probabilities (Figure 7.4.3.2).

The catch options table (Table 7.4.2.3) is calculated using the probability density function of the pre-fishery abundance forecasts and point estimates for the remaining parameters including the spawner reserve for North America and biological characteristics in the fishery (proportion of the 1SW catch which would be of North American origin, weight of 1SW North American and European fish, and the age correction factor). In the risk analysis, the biological characteristics for 2002 were assumed to potentially vary between the minimum and maximum values of the previous five years fisheries, 1997 to 2002.

The final step in the risk analysis of the catch options involves combining the conservation requirement with the probability distribution of the returns to North America for different catch options. The returns to North America are partitioned into regional returns based on the proportions lagged spawners for 2002. Estimated returns to each region are compared to the conservation objectives of Labrador, Newfoundland, Quebec, and Gulf. Estimated returns for Scotia-Fundy and US are compared to the objective of achieving at least a 10% increase or a 25% increase relative to average returns of the previous five years. The input parameters for the risk analysis are in Table 7.4.3.2.

The pre-fishery abundance of salmon in 2002 is expected to be moderate relative to recent years (Figure 7.4.3.2). In the absence of any marine induced fishing mortality, there is a high probability (85% probability) that the returns of 2SW salmon to North America in 2002 will be sufficient to meet the conservation requirements of the four northern regions (Labrador, Newfoundland, Quebec, and Gulf) (Table 7.4.3.3; Figure 7.4.3.3). There is also a high probability that the returns in the southern regions (Scotia-Fundy and USA) will increase by at least 10% relative to the returns of the previous five years if the predicted PFA abundance is realized.

There are no fishery allocations that will ensure (probability of 0.99) the objective of achieving the conservation requirements for 2SW salmon in the four northern regions or an alternative objective of seeing an increased number of 2SW salmon returning to the under escaped southern regions of North America. At a quota of 70 t in West Greenland and a subsequent allocation of 81 t to North America (based on the historical sharing agreement of 40:60), there is at best a 75% chance of meeting the conservation objectives in the four northern regions.

ICES concludes that the North American stock complex of non-maturing salmon remains in tenuous condition.

Increased spawning escapements to rivers of some areas of eastern North America resulted in improved abundance at the juvenile life stages, and perhaps now at adult life stages. Despite the closure of Canadian commercial fisheries in 1992 and subsequently in Labrador in 1998 and Quebec in 1999, sea survival of adults returning to rivers has not improved and in some areas has declined further. The abundance of maturing 1SW salmon has also declined in many areas of eastern North America. Associations between 1SW returns in year i and 2SW returns in year i+1 observed in several rivers in eastern Canada suggest that abundance of 2SW salmon in 2002 in eastern Canada will be similar to or less than recent years. Smolt production in 2000 and 2001 in monitored rivers of eastern Canada were similar to or below the average of the last five years and unless sea survival improves, the abundance of non-maturing 1SW salmon in the Northwest Atlantic is not expected to improve above the levels of the last five years.

There is little information available to confirm the possibility of an improvement in prefishery abundance in 2001 and 2002 as predicted by the model. One sea winter adult returns in 2002 will provide initial indications regarding the overall abundance of adult salmon in 2003. Although the model has successfully tracked two sharp increases in prefishery abundance previously, caution is urged regarding the harvest decisions for 2002. The increasing advantage associated with each additional spawner in under-seeded river systems makes a strong case for a conservative management strategy.

ICES also noted that the PFA of non-maturing 1SW salmon from Southern Europe has been declining steadily since the 1970s, and the preliminary quantitative prediction of PFA for this stock complex indicates that PFA will remain close to present low levels for each of the next two years (575,000 and 552,000 fish). As there is evidence from the prediction that PFA will decrease in the near future and the spawning escapement has not been significantly above conservation limit for the last six years. The stock group is therefore thought to remain very close to safe biological limits, and ICES therefore considers that precautionary reductions in exploitation rates are required for as many stocks as possible, in order to ensure that conservation requirements are met for each river stock with high probability. ICES also notes that mixed stock fisheries present particular threats to conservation.

Therefore, ICES considers the stock complex at West Greenland to be outside safe biological limits and recommends that there should be no exploitation of the 2001 smolt cohort as non-maturing 1SW fish in North America or at Greenland in 2002, and also recommends that the cohort should not be exploited as mature 2SW fish in North America in 2003. Exceptions are in-river harvests from stocks which can be shown to be above biologically-based spawning escapement requirements. Further, exploitation rate**s** on this cohort (including possible by-catch in other fisheries) should be minimised in the North American Commission and in the West Greenland Commission Areas. It should also be noted that the assessment of stocks in Southern Europe, which are also exploited at West Greenland, has shown that these stocks are at, or below, their conservation limits and this further supports the advice for no fishery at West Greenland.

There are no fishery allocations that will ensure the objective of achieving the conservation requirements for 2SW salmon in the four northern regions together with the objective of seeing an increased number of 2SW salmon returning to the under escaped southern regions of North America. If, as occurred last year, a fishery is allowed at West Greenland, management measures should be set so that the probability of attaining conservation limits in the four northern regions of North America would be at least 75%. This will also ensure that some rebuilding in the southern regions (Scotia Fundy, USA) occurs.

ICES reiterates that, in order to meet conservation limits in all areas of North America, there should be no catch at West Greenland.

7.5 Changes to the model used to provide catch advice

There were no changes to the model structure used to forecast pre-fishery abundance (PFA) of non-maturing 1SW salmon or methods used to provide catch advice for the West Greenland fishery. However, a revised estimate of natural mortality occurring at sea has been adopted. Previous to this assessment, ICES used an instantaneous rate of natural mortality of 0.01 per month in the NEAC and NAC models to estimate PFA of salmon. Based on analytical work completed and reviewed over the past two years, a revised estimate of 0.03 per month was adopted for use in estimating PFA (see Section 7.2.1).

Natural mortality enters into the PFA model used to estimate the non-maturing 1SW component at the stage when the numbers of salmon alive at the beginning of the second sea winter are back-calculated from the estimated numbers of fish returning to home waters. Increasing natural mortality from 0.01 to 0.03 per month increases both the estimated PFA and conservation limit of non-maturing salmon by approximately 20%. In addition, the harvestable surplus of salmon (if a surplus exists) will also increase by the same amount. However, salmon not taken in the fishery (assuming that the full quota is harvested) will also be subject to the higher level of natural mortality, and as a result there is no change in the estimated numbers of fish returning to homewaters. It should also be noted that for 2003, the lagged spawner variable will need to be revised to account for missing data from Labrador and this will necessarily result in a change in the current model or development of alternative models.

It is anticipated that output from the NEAC PFA forecast model will be incorporated into the catch options advice for West Greenland.

7.6 Data deficiencies, monitoring needs and research requirements in the WGC area

1) Continued efforts should be made to improve the estimates of the annual catches of salmon taken for private sales and local consumption in Greenland.

2) The mean weights, sea and freshwater ages and continent of origin are essential parameters to provide catch advice for the West Greenland fishery. ICES recommends that the sampling program be continued and closely coordinated with fishery harvest plan to be executed annually in West Greenland.

3) Scale analysis of salmon captured at West Greenland indicated an infrequent appearance of escaped-farm salmon. To investigation this observation, farmed salmon need to be genetically characterized and included as baseline populations in continent of origin analyses of samples collected at West Greenland.

4) Continue testing for ISAv and other diseases in Atlantic salmon caught in West Greenland.

5) Development of more refined data characterizing fishing effort (e.g., vessel size, gear type, amount of gear deployed, soak time) would allow for detailed analyses of CPUE data to characterize availability of Atlantic salmon in West Greenland.

6) Future analyses should focus on partitioning total mortality into fishing and natural mortality to assess changes in fishing mortality related to management. Further, efforts should focus on evaluating sensitivity to detect changes attributed specifically to management actions in homewaters.

7) Development of alternative in-season measures of abundance such as relationships between 1SW returns to rivers from the same cohort should be investigated as a future source of confirmatory information of abundance.

8) The catch options for the West Greenland fishery are based almost entirely upon data taken from North American stocks. In view of the evidence of a long-term decline in the European stock components contributing to this fishery (southern European non-maturing 1SW recruits), ICES emphasized the need for information from these stocks to be incorporated into the modelling and abundance forecasts as soon as possible.

9) Further basic research is needed on the spatial/temporal distribution and migration patterns of salmon and their predators at sea to assist in explaining variability in survival rates.

10) Other indices of change, i.e., changes in age composition, size at age and sea survival, should also be included in this evaluation.

11) An ICES Study Group is needed to allow for a focused effort to investigate alternative models and management systems for providing scientific catch advice for mixed stock and homewater fisheries.

12) Development of alternative in-season measures of abundance such as relationships between 1SW returns to rivers from the same cohort should be investigated as a future method to confirm abundance.

Table 4.1.1.1 Nominal catch of SALMON by country (in tonnes round fresh weight), 1960-2001. (2001 figures include provisional data).

Year	Canada (1)	Den.	Faroes (2)	Finland	France	East Grld.	West Grld. (3)	Iceland Wild	Iceland Ranch	Ireland (4,5)	Norway (6)	Russia (7)	Spain (8)	St. P. & M.	Sweden (West)	UK (E & W) (12)	UK (N.Irl.) (5,9)	UK (Scotl.)	USA	Other (10)	Total Reported Catch	Unreported catches NASCO Areas	Unreported catches International waters (11)
1960	1636	-	-	-	-	-	60	100		743	1659	1100	33	-	40	283	139	1443	1	-	7237	-	-
1961	1583	-	-	-	-	-	127	127		707	1533	790	20	-	27	232	132	1185	1	-	6464	-	-
1962	1719	-	-	-	-	-	244	125		1459	1935	710	23	-	45	318	356	1738	1	-	8673	-	-
1963	1861	-	-	-	-	-	466	145		1458	1786	480	28	-	23	325	306	1725	1	-	8604	-	-
1964	2069	-	-	-	-	-	1539	135		1617	2147	590	34	-	36	307	377	1907	1	-	10759	-	-
1965	2116	-	-	-	-	-	861	133		1457	2000	590	42	-	40	320	281	1593	1	-	9434	-	-
1966	2369	-	-	-	-	-	1370	104	2	1238	1791	570	42	-	36	387	287	1595	1	-	9792	-	-
1967	2863	-	-	-	-	-	1601	144	2	1463	1980	883	43	-	25	420	449	2117	1	-	11991	-	-
1968	2111	-	5	-	-	-	1127	161	1	1413	1514	827	38	-	20	282	312	1578	1	403	9793	-	-
1969	2202	-	7	-	-	-	2210	131	2	1730	1383	360	54	-	22	377	267	1955	1	893	11594	-	-
1970	2323	-	12	-	-	-	2146	182	13	1787	1171	448	45	-	20	527	297	1392	1	922	11286	-	-
1971	1992	-	-	-	-	-	2689	196	8	1639	1207	417	16	-	18	426	234	1421	1	471	10735	-	-
1972	1759	-	9	32	34	-	2113	245	5	1804	1578	462	40	-	18	442	210	1727	1	486	10965	-	-
1973	2434	-	28	50	12	-	2341	148	8	1930	1726	772	24	-	23	450	182	2006	2.7	533	12670	-	-
1974	2539	-	20	76	13	-	1917	215	10	2128	1633	709	16	-	32	383	184	1628	0.9	373	11877	-	-
1975	2485	-	28	76	25	-	2030	145	21	2216	1537	811	27	-	26	447	164	1621	1.7	475	12136	-	-
1976	2506	-	40	66	9	<1	1175	216	9	1561	1530	542	21	2.5	20	208	113	1019	0.8	289	9327	-	-
1977	2545	-	40	59	19	6	1420	123	7	1372	1488	497	19	-	10	345	110	1160	2.4	192	9414	-	-
1978	1545	-	37	37	20	8	984	285	6	1230	1050	476	32	-	10	349	148	1323	4.1	138	7682	-	-
1979	1287	-	119	26	10	<0,5	1395	219	6	1097	1831	455	29	-	12	261	99	1076	2.5	193	8118	-	-
1980	2680	-	536	34	30	<0,5	1194	241	8	947	1830	664	47	-	17	360	122	1134	5.5	277	10127	-	-
1981	2437	-	1025	44	20	<0,5	1264	147	16	685	1656	463	25	-	26	493	101	1233	6	313	9954	-	-
1982	1798	-	606	54	20	<0,5	1077	130	17	993	1348	364	10	-	25	286	132	1092	6.4	437	8395	-	-
1983	1424	-	678	58	16	<0,5	310	166	32	1656	1550	507	23	3	28	429	187	1221	1.3	466	8755	-	-
1984	1112	-	628	46	25	<0,5	297	139	20	829	1623	593	18	3	40	345	78	1013	2.2	101	6912	-	-
1985	1133	-	566	49	22	7	864	162	55	1595	1561	659	13	3	45	361	98	913	2.1	-	8108	-	-
1986	1559	-	530	37	28	19	960	232	59	1730	1598	608	27	2.5	54	430	109	1271	1.9	-	9255	315	-
1987	1784	-	576	49	27	<0,5	966	181	40	1239	1385	564	18	2	47	302	56	922	1.2	-	8159	2788	-
1988	1310	-	243	36	32	4	893	217	180	1874	1076	420	18	2	40	395	114	882	0.9	-	7737	3248	-
1989	1139	-	364	52	14	-	337	140	136	1079	905	364	7	2	29	296	142	895	1.7	-	5903	2277	-
1990	911	13	315	60	15	-	274	146	280	567	930	313	7	1.9	33	338	94	624	2.4	-	4924	1890	180-350

Table 4.1.1.1 (Continued)

Year	Canada (1)	Den.	Faroes (2)	Finland	France	East Grld.	West Grld. (3)	Iceland Wild	Iceland Ranch	Ireland (4,5)	Norway (6)	Russia (7)	Spain (8)	St. P. & M.	Sweden (West)	UK (E & W) (12)	UK (N.Irl.) (5,9)	UK (Scotl.)	USA	Other (10)	Total Reported Catch	Unreported catches NASCO Areas	Unreported catches International waters (11)
1991	711	3.3	95	70	13	4	472	130	345	404	876	215	11	1.2	38	200	55	462	0.8	-	4106	1682	25-100
1992	522	10	23	77	20	5	237	175	460	630	867	167	11	2.3	49	171	91	600	0.7	-	4118	1962	25-100
1993	373	9	23	70	16	-	-	160	496	541	923	139	8	2.9	56	248	83	547	0.6	-	3696	1644	25-100
1994	355	6	6	49	18	-	-	140	308	804	996	141	10	3.4	44	324	91	649	0	-	3944	1276	25-100
1995	260	3.1	5	48	9	2	83	150	298	790	839	128	9	0.8	37	295	83	588	0	-	3628	1060	-
1996	292	1.7	-	44	14	0.1	92	122	239	687	787	131	7	1.6	33	183	77	427	0	-	3138	1123	-
1997	229	1.3	-	45	8	1	58	106	50	571	630	111	3	1.5	19	142	93	296	0	-	2365	827	-
1998	157	1.3	6	48	9	0	11	130	34	624	740	131	4	2.3	15	123	78	283	0	-	2397	1210	-
1999	152	0.5	0	62	11	0.4	19	119	26	515	811	103	6	2.3	16	150	53	199	0	-	2245	1027	-
2000	153	5.2	8	95	11	0	21	82	2	621	1176	124	-	2.3	33	219	78	274	0	-	2905	1265	-
2001	145	6.4	0	125	11	0	43	87	0	769	1267	114	12	2.2	33	183	53	227	0	-	3078	1170	-
Means																							
1996-2000	197	2	5	59	11	0	40	112	70	604	829	120	5	2	23	163	76	296	0	-	2610	1090	-
1991-2000	320	4	21	61	13	2	124	131	226	619	865	139	8	2	34	206	78	433	0	-	3254	1308	-

1. Includes estimates of some local sales, and, prior to 1984, by-catch.
2. Between 1991 & 1999, there was only a research fishery at Faroes.

In 1997 & 1999 no fishery took place, the commercial fishery resumed in 2000

3. Includes catches made in the West Greenland area by Norway, Faroes, Sweden and Denmark in 1965-1975.
4. From 1994, includes increased reporting of rod catches.
5. Catch on River Foyle allocated 50% Ireland and 50% N. Ireland.
6. Before 1966, sea trout and sea charr included (5% of total).
7. Figures from 1991 to 2000 do not include catches taken in the recently developed recreational (rod) fishery.
8. Weights prior to 1990 are estimated from 1994 mean weight. Weights from 1990 to 1999 based on mean wt. from R. Asturias. Weights for 2001 based on mean wt. from french 2001 rod catches (1 SW : 2.35 kg ; 2 SW : 4.57 kg).
9. Not including angling catch (mainly 1SW).
10. Includes catches in Norwegian Sea by vessels from Denmark, Sweden, Germany, Norway and Finland.
11. Estimates refer to season ending in given year.
12. Data for 1993-98 altered from previous reports to take account of catch & release

Table 4.2.1.1 Monthly mortality rate estimates for River Bush hatchery smolts from the 1974 to 1976 releases (data from Doubleday *et al*. 1979) and for the 1999 hatchery smolts (W. Crozier, Unpubl. Data).

Stock	Growth Model	Age Group	Smolt Cohort	Lifetime Survival	Mortality - 2nd Year at Sea 314 days	Monthly
River Bush Hatchery smolts	Exponential	Age-1	All three	8.5%	3.4%	0.3%
		Age-2,2+	All three	34.3%	1.5%	0.1%
		Age-1	1974	8.4%	3.4%	0.3%
			1975	13.0%	2.8%	0.3%
			1976	8.5%	3.4%	0.3%
		Age-2,2+	1974	26.8%	1.8%	0.2%
			1975	n.e.	n.e.	n.e.
			1976	24.5%	1.9%	0.2%
	Linear	Age-1	All three	7.3%	17.0%	1.8%
		Age-2,2+	All three	31.9%	7.8%	0.8%
		Age-1	1974	6.7%	17.5%	1.8%
			1975	10.9%	14.6%	1.5%
			1976	8.4%	16.2%	1.7%
		Age-2,2+	1974	24.7%	9.5%	0.9%
			1975	n.e.	n.e.	n.e.
			1976	22.4%	10.1%	1.0%
	Growth Model	**Growth Data**	**Smolt Cohort**	**Lifetime Survival**	**Mortality - 2nd Year at Sea 11 months**	**Monthly**
River Bush Age-1 Hatchery	Exponential	Doubleday et al. 1979	1999	2.7%	10.5%	1.0%
		W. Crozier (Unpubl. Data)	1999	2.4%	19.2%	1.9%
	Linear	Doubleday et al. 1979	1999	2.2%	28.0%	2.9%
		W. Crozier (Unpubl. Data)	1999	2.2%	28.0%	2.9%

Table 4.2.1.2 Summary of monthly mortality rate estimates during the second year at sea for various stocks of Atlantic salmon in the North Atlantic.

Stock	Origin	Smolt cohorts			N	Method of estimation	Mortality rate (% per month) Median	Min.	Max.
North America									
LaHave River	Wild	1996	to	1999	4	Inverse-weight	2.8%	2.3%	3.3%
LaHave River	Hatchery	1972	to	1999	28	Inverse-weight	3.3%	2.3%	4.4%
Northwest Miramichi	Wild	1999	to	1999	1	Inverse-weight	2.7%	-	-
River Trinite	Wild	1984	to	1999	16	Inverse-weight	3.4%	2.9%	4.3%
Sandhill River	Wild	1969	to	1971	3	Inverse-weight	1.5%	1.4%	1.7%
Saint John River	Hatchery: age-1 smolts	1991	to	1998	7	Maturity schedule	17.6%	11.5%	20.8%
LaHave River	Wild	1996	to	1996	1	Maturity schedule	12.0%		
River Trinite	Wild	1984	to	1990	7	Maturity scehdule	12.6%	7.9%	14.7%
River Trinite	Wild	1991	to	1999	9	Maturity scehdule	5.1%	1.4%	9.1%
Miramchi River	Wild	1983	to	1997	15	Maturity schedule	12.4%	3.6%	19.2%
NEAC									
River Bush	Hatchery: age-1 smolts	1974	to	1976	3	Inverse-weight	1.7%	1.5%	1.8%
	Hatchery: age-2 smolts	1974	to	1976	3	Inverse-weight	1.0%	0.9%	1.0%
	Hatchery: age-1 smolts	1999	to	1999	1	Inverse-weight	2.9%	-	-
River Scorff	Wild	1995	to	1997	3	Maturity schedule	16.2%	15.6%	16.7%

Table 4.2.2.1 Percentage increase in estimated NEAC PFA resulting from increasing M from 0.01 to levels between 0.015 and 0.050 per month. (Return times for 1SW and MSW salmon are assumed to be 8 months and 17 months respectively)

New M	**Percentage increase in estimated PFA**	
	1SW	**MSW**
	(for 8 months)	**(for 17 months)**
0.015	4%	9%
0.020	8%	19%
0.025	13%	29%
0.030	17%	40%
0.035	22%	53%
0.040	27%	67%
0.045	32%	81%
0.050	38%	97%

Table 4.2.2.2 Effects on estimates of PFA, CL, SER, Harvestable surplus, etc. for Southern European MSW salmon stocks for M equal to 0.01 and 0.03 per month.

	Current M	New M	Effect of higher M
adult M	0.010	0.030	
time (months)	17.0	17.0	
Est. returns	600,000	600,000	
Est. PFA	711,183	999,175	40%
CL	501,445	501,445	0%
SER	594,365	835,052	40%
Harvestable surplus	116,818	164,123	40%
40% allocation to fishery	46,727	65,649	40%
Survivors from fishery	664,456	933,526	40%
Returns to HWs	560,578	560,578	0%

Table 4.3.7.1. Summary of Atlantic salmon tagged and marked in 2001. 'Hatchery' and 'Wild' refer to smolts or parr; 'Adult' refers to wild and hatchery fish. Data from Belgium and Spain were not available. Fish were not tagged in Finland. PIT tags were not included.

		Primary Tag or Mark			
Country	Origin	Microtag	External mark	Adipose clip	Total
Canada	Hatchery	0	44,334	1,870,421	1,914,755
	Wild	0	13,097	101	13,198
	Adult	0	6,320	0	6,320
	Total	0	63,751	1,870,522	1,934,273
Denmark	Hatchery	3	3	3	9
	Wild	3	3	3	9
	Adult	3	3	3	9
	Total	9	9	9	27
France	Hatchery	0	2,489	297,604	300,093
	Wild	0	0	0	0
	Adult	0	0	0	0
	Total	0	2,489	297,604	300,093
Iceland	Hatchery	139,041	0	0	139,041
	Wild	2,183	0	0	2,183
	Adult	0	217	0	217
	Total	141,224	217	0	141,441
Ireland	Hatchery	267,967	0	0	267,967
	Wild	3,755	0	0	3,755
	Adult	0	0	0	0
	Total	271,722	0	0	271,722
Norway	Hatchery	0	40,418	0	40,418
	Wild	0	3,893	0	3,893
	Adult	0	153	0	153
	Total	0	44,464	0	44,464
Russia	Hatchery	0	1,000	585,300	586,300
	Wild	0	94	0	94
	Adult	0	2,860	0	2,860
	Total	0	3,954	585,300	589,254
Sweden	Hatchery	0	4,920	31,285	36,205
	Wild	0	287	0	287
	Adult	0	0	0	0
	Total	0	5,207	31,285	36,492
UK (England & Wales)	Hatchery	55,445	5,136	136,231	196,812
	Wild	364	1,551	1,715	3,630
	Adult	0	1,187	0	1,187
	Total	55,809	7,874	137,946	201,629
UK (N. Ireland)	Hatchery	32,321	0	46,853	79,174
	Wild	1,350	0	0	1,350
	Adult	0	0	0	0
	Total	33,671	0	46,853	80,524
UK (Scotland)	Hatchery	6,250	0	0	6,250
	Wild	6,751	4,592	0	11,343
	Adult	500	2,434	0	2,934
	Total	13,501	7,026	0	20,527
USA	Hatchery	0	249,744	0	249,744
	Wild	0	1,578	0	1,578
	Adult	0	5,340	0	5,340
	Total	0	256,662	0	256,662
All Countries	Hatchery	501,037	348,054	2,967,707	3,816,798
	Wild	14,416	25,105	1,829	41,350
	Adult	513	18,524	13	19,050
	Total	515,966	391,683	2,969,549	3,877,198

Table 5.3.1 Bootstrapped probability distribution of forecast for 2002

Probability level	Forecast
10%	418,706
20%	463,962
30%	500,049
40%	532,903
50%	552,000
60%	603,756
70%	659,714
80%	731,029
90%	813,182

Table 6.1.2.1 Definitions of key variables used in continental run-reconstruction models for North American salmon.

i	Year of the fishery on 1SW salmon in Greenland and Canada
M	Natural mortality rate (0.03 per month)
t1	Time between the mid-point of the Canadian fishery and return to river = 1 months
S1	Survival of 1SW salmon between the homewater fishery and return to river {exp(-M t1)}
H_s(i)	Number of "Small" salmon caught in Canada in year i; fish <2.7 kg
H_l(i)	Number of "Large" salmon caught in Canada in year i; fish >=2.7 kg
AH_s	Aboriginal and resident food harvests of small salmon in northern Labrador
AH_l	Aboriginal and resident food harvest of large salmon in northern Labrador
f_imm	Fraction of 1SW salmon that are immature, i.e., non-maturing: range = 0.1 to 0.2
af_imm	Fraction of 1SW salmon that are immature in native and resident food fisheries in N Labrador
q	Fraction of 1SW salmon present in the large size market category; range = 0.1 to 0.3
MC1(i)	Harvest of maturing 1SW salmon in Newfoundland and Labrador in year i
i+1	Year of fishery on 2SW salmon in Canada
MR1(i)	Return estimates of maturing 1SW salmon in Atlantic Canada in year i
NN1(i)	Pre-fishery abundance of non-maturing 1SW + maturing 2SW salmon in year i
NR(i)	Return estimates of non-maturing + maturing 2SW salmon in year i
NR2(i+1)	Return estimates of maturing 2SW salmon in Canada
NC1(i)	Harvest of non-maturing 1SW salmon in Nfld + Labrador in year i
NC2(i+1)	Harvest of maturing 2SW salmon in Canada
NG(i)	Catch of 1SW North American origin salmon at Greenland
S2	Survival of 2SW salmon between Greenland and homewater fisheries
MN1(i)	Pre-fishery abundance of maturing 1SW salmon in year I
RFL1	Labrador raising factor for 1SW used to adjust pre-fishery abundance
RFL2	Labrador raising factor for 2SW used to adjust pre-fishery abundance

Table 3.1.2 Run reconstruction data inputs for harvests used to estimate pre-fishery abundance of maturing and non-maturing 1SW salmon of North American origin (terms defined in Table 4.2.3.2).

	{1}			{1-7, 14b}		{8-14a}		{1-7, 14b}
1SW Year (i)	AH_Small (i)	AH_Large (i+1)	AH_Large (i)	H_Small (i)	H_Large (i)	H_Small (i)	H_Large (i+1)	H_Large (i+1)
1971	0	0	0	158896	199176	70936	42861	144496
1972	0	0	0	143232	144496	111141	43627	227779
1973	0	0	0	188725	227779	176907	85714	196726
1974	0	0	0	192195	196726	153278	72814	215025
1975	0	0	0	302348	215025	91935	95714	210858
1976	0	0	0	221766	210858	118779	63449	231393
1977	0	0	0	220093	231393	57472	37653	155546
1978	0	0	0	102403	155546	38180	29122	82174
1979	0	0	0	186558	82174	62622	54307	211896
1980	0	0	0	290127	211896	94291	38663	211006
1981	0	0	0	288902	211006	60668	35055	129319
1982	0	0	0	222894	129319	77017	28215	108430
1983	0	0	0	166033	108430	55683	15135	87742
1984	0	0	0	123774	87742	52813	24383	70970
1985	0	0	0	178719	70970	79275	22036	107561
1986	0	0	0	222671	107561	91912	19241	146242
1987	0	0	0	281762	146242	82401	14763	86047
1988	0	0	0	198484	86047	74620	15577	85319
1989	0	0	0	172861	85319	60884	11639	59334
1990	0	0	0	104788	59334	46053	10259	39257
1991	0	0	0	89099	39257	42721	0	32341
1992	0	0	0	24249	32341	0	0	17096
1993	0	0	0	17074	17096	0	0	15377
1994	0	0	0	8640	15377	0	0	11176
1995	0	0	0	7980	11176	0	0	7272
1996	0	0	0	7849	7272	0	0	6943
1997	0	2269	0	9753	6943	0	0	0
1998	2988	1084	2269	0	0	0	0	0
1999	2739	1352	1084	0	0	0	0	0
2000	5323	2334	1352	0	0	0	0	0
2001	4730	0	2334	0	0	0	0	0

Table 6.5.1.1 Catch options for 2002 North American fisheries

Catch Options for 2002 North American Fisheries (Probability levels refer to probability density function estimates of pre-fishery abundance)

Probability Level	Pre-fishery Abundance Forecast	Catch Options in 2SW Salmon Equivalents (no.)
25	209,095	0
30	232,019	6,935
35	255,481	23,802
40	279,932	41,381
45	305,300	59,618
50	332,455	79,141

Table 6.5.1.2 Fishing mortalities of 2 SW salmon equivalents by North American fisheries, 1972-2002. Only mid-points of the estimated values have been used.

T

Year	CANADA										USA	Total	
	MIXED STOCK				TERMINAL FISHERIES IN YEAR i								
	NF-LAB Comm 1SW (Yr i-1) (b)	% 1SW of total 2SW equivalents	NF-LAB Comm 2SW (Yr i) (b)	NF-Lab comm total	Labrador rivers (a)	Nfld rivers (a)	Quebec Region	Gulf Region	Scotia - Fundy Region	Canadian total	Year i		Terminal Fisheries as a % of Total
1972	20,857	9	153,775	174,632	314	633	27,417	22,389	6,801	232,187	346	232,532	25
1973	17,971	6	219,175	237,146	719	895	32,751	17,915	6,680	296,107	327	296,434	20
1974	24,564	7	235,910	260,475	593	542	47,631	21,429	12,734	343,404	247	343,651	24
1975	24,181	7	237,598	261,779	241	528	41,097	15,675	12,375	331,694	389	332,084	21
1976	35,801	10	256,586	292,388	618	412	42,139	18,088	11,111	364,757	191	364,948	20
1977	27,519	8	241,217	268,736	954	946	42,301	33,433	15,562	361,931	1,355	363,287	26
1978	27,836	11	157,299	185,135	580	559	37,421	23,803	10,781	258,278	894	259,172	29
1979	14,086	10	92,058	106,144	469	144	25,234	6,299	4,506	142,796	433	143,229	26
1980	20,894	6	217,209	238,103	646	699	53,567	29,828	18,411	341,253	1,533	342,785	31
1981	34,486	11	201,336	235,822	384	485	44,375	16,326	13,988	311,381	1,267	312,648	25
1982	34,341	14	134,417	168,757	473	433	35,204	25,707	12,353	242,927	1,413	244,339	31
1983	25,701	12	111,562	137,263	313	445	34,472	27,094	13,515	213,102	386	213,488	36
1984	19,432	14	82,807	102,238	379	215	24,408	6,041	3,971	137,253	675	137,928	26
1985	14,650	11	78,760	93,410	219	15	27,483	2,745	4,930	128,802	645	129,447	28
1986	19,832	12	104,890	124,723	340	39	33,846	4,582	2,824	166,354	606	166,959	25
1987	25,163	13	132,208	157,371	457	20	33,807	3,795	1,370	196,820	300	197,120	20
1988	32,081	21	81,130	113,211	514	29	34,262	3,922	1,373	153,311	248	153,559	26
1989	22,197	16	81,355	103,551	337	9	28,901	3,513	265	136,575	397	136,972	24
1990	19,577	18	57,359	76,937	261	24	27,986	2,847	593	108,649	696	109,344	30
1991	12,048	14	40,433	52,481	66	16	29,277	1,942	1,331	85,114	231	85,344	39
1992	9,979	14	25,108	35,087	581	67	30,016	4,412	1,114	71,278	167	71,445	51
1993	3,229	7	13,273	16,502	273	63	23,153	2,977	1,110	44,078	166	44,244	63
1994	2,139	5	11,938	14,077	365	80	24,052	2,382	756	41,712	1	41,714	66
1995	1,242	3	8,677	9,918	420	92	23,331	2,025	330	36,116	0	36,116	73
1996	1,075	3	5,646	6,721	320	108	22,413	2,587	766	32,915	0	32,915	80
1997	969	3	5,390	6,360	175	136	18,574	2,085	581	27,910	0	27,910	77
1998	1,155	7	1,872	3,027	268	129	11,256	2,291	322	17,292	0	17,292	82
1999	179	1	894	1,073	268	111	9,032	1,387	450	12,320	0	12,320	91
2000	152	1	1,115	1,267	268	372	9,425	2,058	193	13,583	0	13,583	91
2001	286	2	1,925	2,212	268	264	10,104	2,055	255	15,157	0	15,157	85
2002	268	-	-	-	-	-	-	-	-	-	-	-	-

NF-Lab comm as 1SW = NC1(mid-pt) * 0.677057 (M of 0.03 per month for 13 months to July for Canadian terminal fisheries)
NF-Lab comm as 2SW = NC2 (mid-pt) * 0.970446 (M of 0.03 per month for 1 month to July of Canadian terminal
Terminal fisheries = 2SW returns (mid-pt) - 2SW spawners (mid-pt)
a - starting in 1993, includes estimated mortality of 10% on hook and released fish
b - starting in 1998, there was no commercial fishery in Labrador; numbers reflect size of aboriginal fish harvest in 1998-2001 and resident food fishery harvest in 2000-

Table 6.5.1.3 History of fishing related mortalities of North American salmon as equivalents, 1972-2002.

Year	Canadian total	USA total	North America Grand Total	% USA of Total North American	Greenland total	NW Atlantic Total	Harvest in homewaters as % of total NW Atlantic
1972	232,187	346	232,532	0.15	206,814	439,347	53
1973	296,107	327	296,434	0.11	144,348	440,782	67
1974	343,404	247	343,651	0.07	173,615	517,266	66
1975	331,694	389	332,084	0.12	158,583	490,667	68
1976	364,757	191	364,948	0.05	200,464	565,412	65
1977	361,931	1,355	363,287	0.37	112,077	475,364	76
1978	258,278	894	259,172	0.34	136,386	395,559	66
1979	142,796	433	143,229	0.30	85,446	228,676	63
1980	341,253	1,533	342,785	0.45	143,829	486,614	70
1981	311,381	1,267	312,648	0.41	135,157	447,805	70
1982	242,927	1,413	244,339	0.58	163,718	408,058	60
1983	213,102	386	213,488	0.18	139,985	353,473	60
1984	137,253	675	137,928	0.49	23,897	161,825	85
1985	128,802	645	129,447	0.50	27,978	157,425	82
1986	166,354	606	166,959	0.36	100,098	267,057	63
1987	196,820	300	197,120	0.15	123,472	320,592	61
1988	153,311	248	153,559	0.16	124,868	278,426	55
1989	136,575	397	136,972	0.29	83,947	220,919	62
1990	108,649	696	109,344	0.64	43,634	152,978	71
1991	85,114	231	85,344	0.27	52,560	137,904	62
1992	71,278	167	71,445	0.23	79,571	151,015	47
1993	44,078	166	44,244	0.38	30,091	74,335	60
1994	41,712	1	41,714	0.00	0	41,714	100
1995	36,116	0	36,116	0.00	0	36,116	100
1996	32,915	0	32,915	0.00	15,343	48,257	68
1997	27,910	0	27,910	0.00	15,776	43,686	64
1998	17,292	0	17,292	0.00	12,088	29,380	59
1999	12,320	0	12,320	0.00	2,175	14,495	85
2000	13,583	0	13,583	0.00	3,863	17,446	78
2001	15,157	0	15,157	0.00	4,005	19,162	79
2002	-	-	-	-	7,053	-	-

Greenland harvest of 2SW equivalents = NG1 * 0.718924 (M of 0.03 per month for 11 months to July of Canadian terminal fisheries)

Table 7.1.1.1 The weighted proportions and numbers of North American and European Atlantic salmon caught at West Greenland 1982-1992 and 1995-2001. Numbers are rounded to the nearest hundred fish.

	Proportion weighted by catch in number		Numbers of Salmon caught	
Year	NA	E	NA	E
1982	57	43	192200	143800
1983	40	60	39500	60500
1984	54	46	48800	41200
1985	47	53	143500	161500
1986	59	41	188300	131900
1987	59	41	171900	126400
1988	43	57	125500	168800
1989	55	45	65000	52700
1990	74	26	62400	21700
1991	63	37	111700	65400
1992	45	55	46900	38500
1993	-	-	-	-
1994	-	-	-	-
1995	67	33	21400	10700
1996	73	27	22400	9700
1997	85	15	18000	3300
1998	79	21	3100	900
1999	91	9	5700	600
2000	65	35	5100	2700
2001	67	33	9849	5389

Table 7.1.2.1. Distribution of commercial fishing effort (excluding private landings) by calendar week (Monday – Sunday beginning on the Monday nearest August 15th) and NAFO statistical area from 1987 to 2001.

Year	Week	1A	1B	1C	1D	1E	1F	XIV	Total
1997	1	0	24	78	10	68	81	0	**261**
	2	2	20	56	8	48	42	1	**177**
	3	2	5	19	0	11	17	3	**57**
	4	0	4	20	0	7	20	9	**60**
	5	1	9	50	6	10	15	15	**106**
	6	0	0	30	4	10	4	3	**51**
	Total	**5**	**62**	**253**	**28**	**153**	**179**	**31**	**712**
1998	1	6	1	3	1	0	8	0	**19**
	2	2	0	4	1	0	4	0	**11**
	3	3	0	2	0	0	3	0	**8**
	4	2	0	0	0	1	1	0	**4**
	5	1	0	2	0	0	3	0	**6**
	6	0	1	1	0	0	1	0	**3**
	7 & Later	1	2	5	2	0	5	0	**15**
	Total	**15**	**4**	**17**	**4**	**1**	**25**	**0**	**66**
1999	1	0	0	1	1	0	6	0	**8**
	2	0	1	13	5	0	0	0	**19**
	3	0	1	8	0	0	1	2	**12**
	4	0	0	9	2	1	7	0	**19**
	5	1	0	4	2	2	0	0	**9**
	6	0	0	10	2	0	1	0	**13**
	7 & Later	2	18	35	29	1	3	0	**88**
	Total	**3**	**20**	**80**	**41**	**4**	**18**	**2**	**168**
2000	**1**	**1**	**1**	**6**	**16**	**2**	**32**	**0**	**58**
2001	1	0	0	0	22	0	64	0	**86**
	2	0	0	5	14	0	37	0	**56**
	3	0	1	15	11	0	25	0	**52**
	4	0	6	7	1	0	24	0	**38**
	5	0	1	10	0	0	15	0	**26**
	6	0	0	7	0	0	5	0	**12**
	7 & Later	0	0	6	1	0	2	0	**9**
	Total	**0**	**8**	**50**	**49**	**0**	**172**	**0**	**280**

Table 7.1.2.2 Commercial (excluding private landings) catch per unit effort [live weight (kg) / landing] by calendar week (Monday – Sunday beginning on the Monday nearest August 15th) from 1997 to 2001.

Year	Week	Effort Units	CPUE (kg/landing-day) by Week	CPUE (kg/landing-day) by Harvest Period	Aggregate CPUE by Harvest Period
1997	1	**261**	89	89	89
	2	**177**	75	72	81
	3	**57**	63		
	4	**60**	59		
	5	**106**	74	68	--
	6	**51**	67		
	Total	**712**	**77**	**77**	--
1998	1	**19**	57	57	57
	2	**11**	44	46	51
	3	**8**	48		
	4	**4**	54		
	5	**6**	59	131	--
	6	**3**	87		
	7 & Later	**15**	190		
	Total	**66**	**85**	**85**	--
1999	1	**8**	82	82	82
	2	**19**	184	136	125
	3	**12**	61		
	4	**19**	171		
	5	**9**	140	83	--
	6	**13**	57		
	7 & Later	**88**	62		
	Total	**168**	**93**		--
2000	**1**	**58**	**343**	**343**	343
2001	1	**86**	115	115	115
	2	**56**	118	107	111
	3	**52**	96		
	4	**38**	161		
	5	**26**	192	153	--
	6	**12**	90		
	7 & Later	**9**	91		
	Total	**280**	**123**	**123**	--

Table. 7.1.4.1 Distribution of coded wire microtag recoveries by NAFO Division and the numbers of tagged fish released for North American and European stocks, 1985 to 1992. Numbers at large represent fish released in the previous year.

Continent	Year	Number of Recoveries by NAFO Division						Total	Number at large
		1A	1B	1C	1D	1E	1F		
N. America	1985	0	0	0	0	0	0	0	
	1986	0	10	0	11	4	1	26	178,888
	1987	0	33	0	43	11	16	103	517,435
	1988	2	25	0	40	12	2	81	702,900
	1989	0	31	0	34	7	0	72	736,722
	1990	0	0	16	29	1	0	46	720,110
	1991	0	0	14	9	5	0	28	962,019
	1992	0	0	31	0	6	14	51	602,675
	All years	2	99	61	166	46	33	407	4,420,749
	%	0.5	24.3	15.0	40.8	11.3	8.1		
Europe	1985	0	14	2	15	3	0	34	
	1986	0	15	0	20	5	4	44	381,766
	1987	0	13	0	18	7	5	43	361,340
	1988	1	10	0	11	6	1	29	490,620
	1989	0	10	0	10	7	0	27	645,742
	1990	0	0	1	3	4	0	8	851,487
	1991	0	0	4	3	2	0	9	848,675
	1992	0	0	7	0	13	10	30	1,097,663
	All years	1	62	14	80	47	20	224	4,677,293
	%	0.4	27.7	6.3	35.7	21.0	8.9		

Pre-fishery abundance estimates, thermal habitat index for February based on sea surface temperature (H2), lagged spawner index for North America excluding Gulf and US spawners (SLNQ), results of a jacknife cross-validation of the multiplicative forecast model, and simulated forecasts.

	Pre-fishery abundance			Thermal Habitat	Lagged spawners (SLNQ)			Jacknife Cross-validation	
Year	Low	High	Mid-point	February (H2)	Low	High	Mid-point	Prediction	Residuals
1971	642,329	819,161	730,745	2,011	.	.	.	.	.
1972	636,223	847,929	742,076	1,990	.	.	.	.	.
1973	767,427	1,001,959	884,693	1,708	.	.	.	.	.
1974	711,852	923,630	817,741	1,862	.	.	.	.	.
1975	801,808	1,032,778	917,293	1,827	.	.	.	.	.
1976	710,616	970,441	840,529	1,676	.	.	.	.	.
1977	574,996	766,338	670,667	1,915	.	.	.	.	.
1978	325,344	423,326	374,335	1,951	35,453	81,767	58,610	425,024	-50,688
1979	725,593	969,695	847,644	2,058	42,626	94,677	68,652	718,629	129,015
1980	626,755	845,327	736,041	1,823	43,173	97,017	70,095	663,245	72,796
1981	589,988	775,253	682,620	1,912	43,268	97,575	70,421	733,879	-51,259
1982	491,695	642,923	567,309	1,703	43,381	98,372	70,876	644,223	-76,914
1983	279,924	399,893	339,909	1,416	40,413	91,967	66,190	425,449	-85,540
1984	290,960	413,606	352,283	1,257	37,647	84,066	60,856	275,323	76,960
1985	455,731	624,417	540,074	1,410	39,344	83,435	61,389	295,522	244,551
1986	490,832	658,410	574,621	1,688	40,567	91,757	66,162	502,977	71,644
1987	444,070	596,354	520,212	1,627	36,636	88,818	62,727	404,174	116,038
1988	359,883	485,729	422,806	1,698	37,131	83,891	60,511	383,809	38,997
1989	279,510	404,579	342,045	1,642	41,955	86,459	64,207	454,430	-112,385
1990	250,138	343,986	297,062	1,503	40,948	81,667	61,307	350,810	-53,748
1991	282,412	405,168	343,790	1,357	37,582	72,966	55,274	210,786	133,004
1992	167,578	256,321	211,949	1,381	35,596	71,384	53,490	206,923	5,027
1993	118,852	224,147	171,500	1,252	38,387	79,232	58,810	277,951	-106,451
1994	137,048	270,162	203,605	1,329	38,395	75,762	57,079	249,397	-45,792
1995	144,618	247,008	195,813	1,311	36,740	69,943	53,342	195,165	648
1996	122,042	192,428	157,235	1,470	33,492	61,600	47,546	151,964	5,271
1997	80,686	146,928	113,807	1,594	29,876	55,241	42,558	118,042	-4,236
1998	68,977	146,973	107,975	1,849	25,629	50,461	38,045	95,636	12,339
1999	67,666	149,236	108,451	1,741	25,658	52,637	39,147	98,008	10,443
2000	81,470	169,954	125,712	1,634	32,960	68,185	50,572	229,349	-103,637
2001	.	.	.	1,685	37,414	81,709	59,561	*332,455* [1]	
2002	.	.	.	1,865	33,942	74,377	54,159	*329,552* [1]	

[1] Simulated forecast values.

Table 7.4.1.2 Input data for the forecast model for Southern European MSW salmon stocks. (See text for explanation of data sources.)

Year	Habitat	Lagged eggs	PFA
1977	1915	4,881,591	1,542,421
1978	1951	4,808,109	1,143,533
1979	2058	4,541,188	1,529,837
1980	1823	3,698,662	1,559,713
1981	1912	3,249,157	1,178,577
1982	1703	3,273,494	1,424,093
1983	1416	3,163,490	994,806
1984	1257	3,038,648	1,150,359
1985	1410	3,094,417	1,568,086
1986	1688	2,984,705	1,195,120
1987	1627	3,762,336	1,474,693
1988	1698	3,272,991	1,367,850
1989	1642	3,466,012	1,032,277
1990	1503	3,990,425	739,319
1991	1357	3,942,158	995,542
1992	1381	4,211,723	861,097
1993	1252	4,254,457	974,718
1994	1329	3,532,550	888,908
1995	1311	2,938,459	711,978
1996	1470	3,138,096	535,690
1997	1594	3,469,051	517,974
1998	1849	3,412,299	442,299
1999	1741	3,286,164	650,946
2000	1634	2,913,060	624,131
2001	1685	2,445,038	
2002	1865	2,360,306	

Table 7.4.1.3 Multiplicative model estimate of pre-fishery abundance for North American salmon in 2002 with probability levels between 5 and 95%.

Cumulative Density Function %	Forecast
5	101880
10	132305
15	157875
20	181472
25	204485
30	227572
35	251166
40	275683
45	301666
50	329552
55	359752
60	392915
65	430495
70	474268
75	526212
80	590251
85	674419
90	797109
95	1021989

Table 7.4.2.1 Quota options (mt) for 2001 at West Greenland based on H2-SLNQ multiplicative forecasts of fishery abundance. Proportion at West Greenland refers to the fraction of harvestable surplus allocated to the West Greenland fishery. The probability level refers to the pre-fishery abundance levels derived from the probability density function.

Prob.	Proportion at West Greenland (Fna)										
level	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
25	0	0	0	0	0	0	0	0	0	0	0
30	0	5	11	16	22	27	33	38	44	49	55
35	0	14	28	42	55	69	83	97	111	125	139
40	0	23	45	68	90	113	136	158	181	203	226
45	0	32	64	95	127	159	191	223	255	286	318
50	0	42	84	125	167	209	251	292	334	376	418

Sp. res =	212,189
Prop NA =	0.803
WT1SWNA =	2.687
WT1SWE =	2.862
ACF =	1.050

Table 7.4.3.1 Total prefishery abundance (PFA) of Atlantic salmon required to meet regional 2SW conservation limits for the six regions of North America.

	2SW Conservation Limit		Lagged spawners for 2002		PFA required to meet regional 2SW conservation limits
Region	Number of fish	Proportion of North America	Number of fish	Proportion of North America	
Labrador	34,746	0.228	22,527	0.305	158,461
Newfoundland	4,022	0.026	7,215	0.098	57,086
Quebec	29,446	0.193	20,286	0.275	148,940
Gulf	30,430	0.199	18,205	0.247	171,365
Scotia-Fundy	24,705	0.162	4,133	0.056	613,640
USA	29,199	0.191	1,400	0.019	2,137,625
Total	152,548	1.000	73,764	1.000	

Table 7.4.3.2 Input parameters for a risk analysis to achieve conservation limits (S_{lim}) for Labrador, Newfoundland, Quebec, and Gulf, while achieving at least a 10% or 25% increase in returns to Scotia-Fundy and USA.

	Management Objective			
	Achieving conservation requirement	Rebuilding of 2SW salmon abundance		
Region	Number of 2SW fish	at ≥ 10% increase	at ≥25% increase	Expected proportion of 2002 PFA
Labrador	34,746			0.305
Newfoundland	4,022			0.098
Quebec	29,446			0.275
Gulf	30,430			0.247
Scotia-Fundy		5,061	5,751	0.056
USA		1,238	1,407	0.019

Table 7.4.3.3 Probability profiles for the management objectives of achieving the 2SW conservation limits simultaneously in the four northern areas of North America (Labrador, Newfoundland, Quebec, Gulf) and achieving the stock rebuilding objectives (examples: minimally 10% or minimally 25% increase in returns of 2SW salmon in 2003) in the two southern areas (Scotia-Fundy and USA) relative to quota options for West Greenland assuming a 40:60 allocation (Fna) of the salmon from North Amrecia.

Probability of meeting management objectives			
Allocation Agreement Greenland @).4 **Tons**	Simultaneous Conservation (Lab, NF, Queb, Gulf)	Simultaneous Rebuilding (SF, USA) >=10% in 2003	>=25% IN 2003
0	0.85	0.93	0.91
5	0.85	0.93	0.90
10	0.84	0.92	0.90
15	0.83	0.92	0.89
20	0.83	0.91	0.88
25	0.82	0.91	0.88
30	0.81	0.90	0.87
35	0.80	0.90	0.87
40	0.80	0.89	0.86
45	0.79	0.88	0.85
50	0.78	0.88	0.84
55	0.77	0.87	0.84
60	0.76	0.87	0.83
65	0.76	0.86	0.82
70	**0.75**	0.85	0.82
75	0.74	0.85	0.81
80	0.73	0.84	0.80
85	0.73	0.83	0.79
90	0.72	0.82	0.78
95	0.71	0.82	0.78
100	0.70	0.81	0.77
110	0.69	0.79	**0.75**
120	0.67	0.78	0.74
130	0.66	0.76	0.72
140	0.64	**0.75**	0.71
150	0.63	0.73	0.69
160	0.61	0.72	0.68
170	0.60	0.70	0.66
180	0.58	0.69	0.65
190	0.57	0.67	0.63
200	0.56	0.66	0.62
225	0.53	0.62	0.58
250	0.49	0.58	0.55

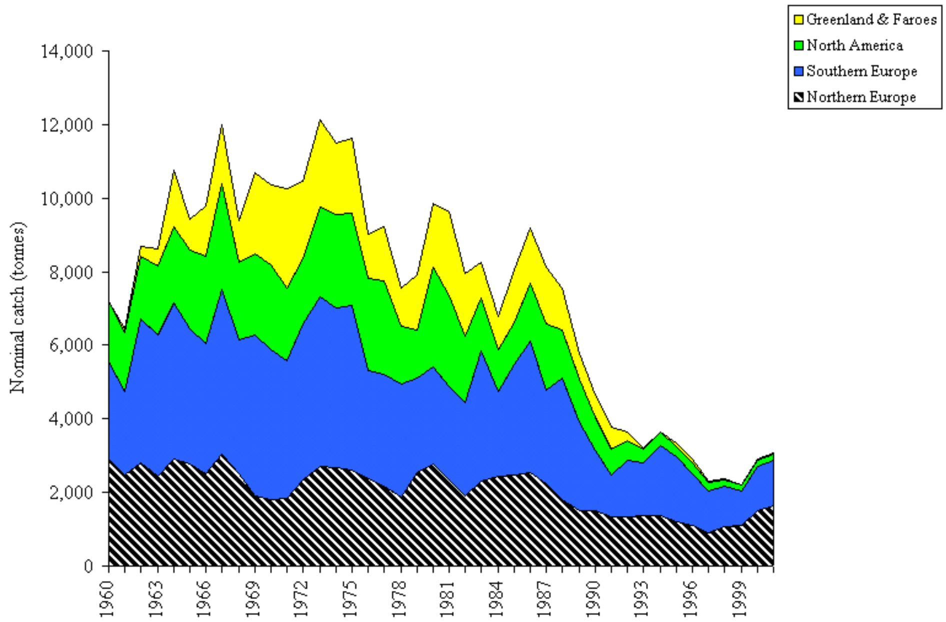


Figure 4.1.1.1 Nominal catches of salmon in four North Atlantic regions 1960–2001

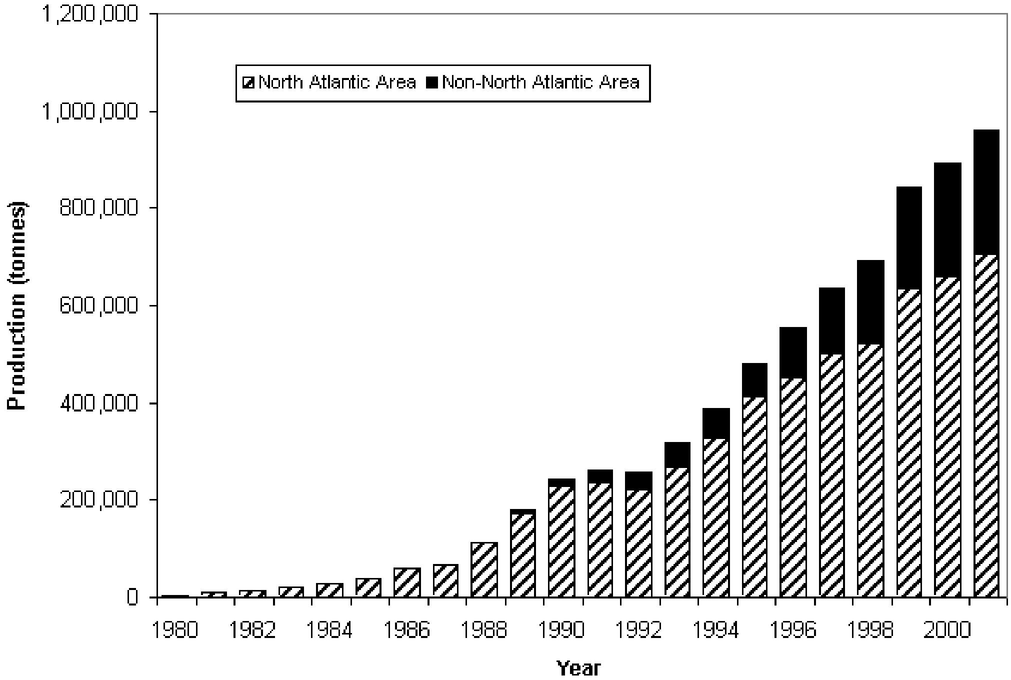


Figure 4.1.4.1 Worldwide production of farmed Atlantic salmon, 1980–2000.

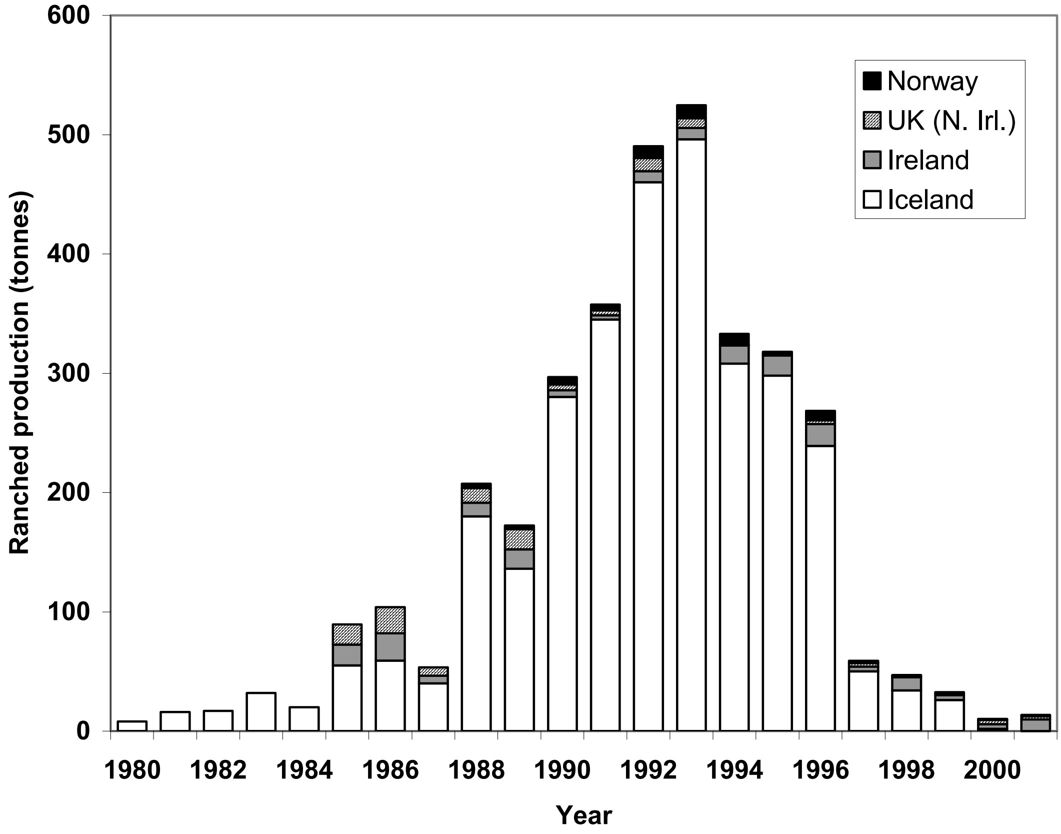


Figure 4.1.4.2 Production of ranched salmon in the North Atlantic, 1980-2001.

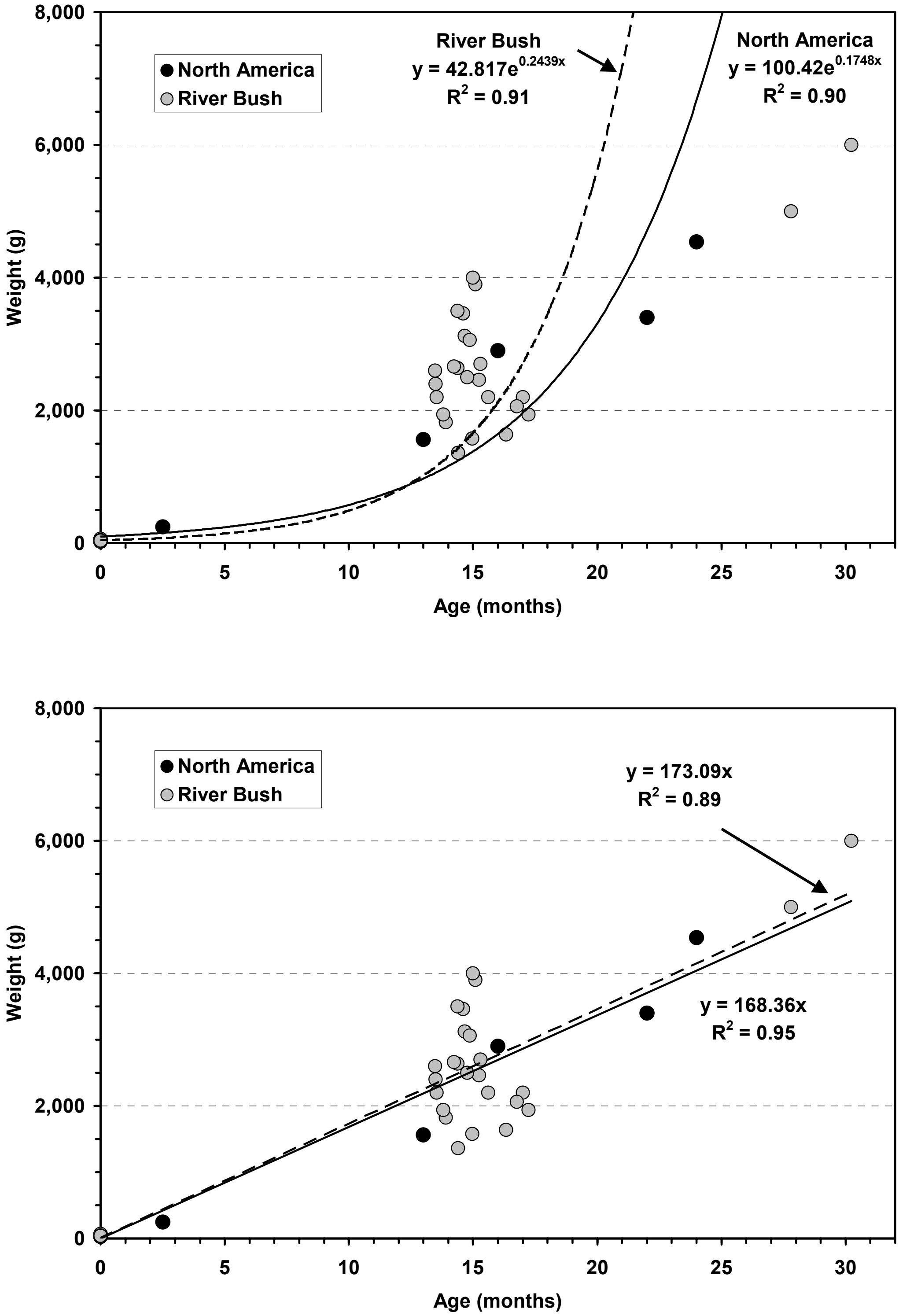


Figure 4.2.1.1 Comparison of weight at sea age (months) data used to model the growth functions of Atlantic salmon from River Bush and Sandhill River (North American stock). Exponential growth functions are in the upper panel, linear growth functions are in the lower panel. Data are from Doubleday *et al*. (1979).

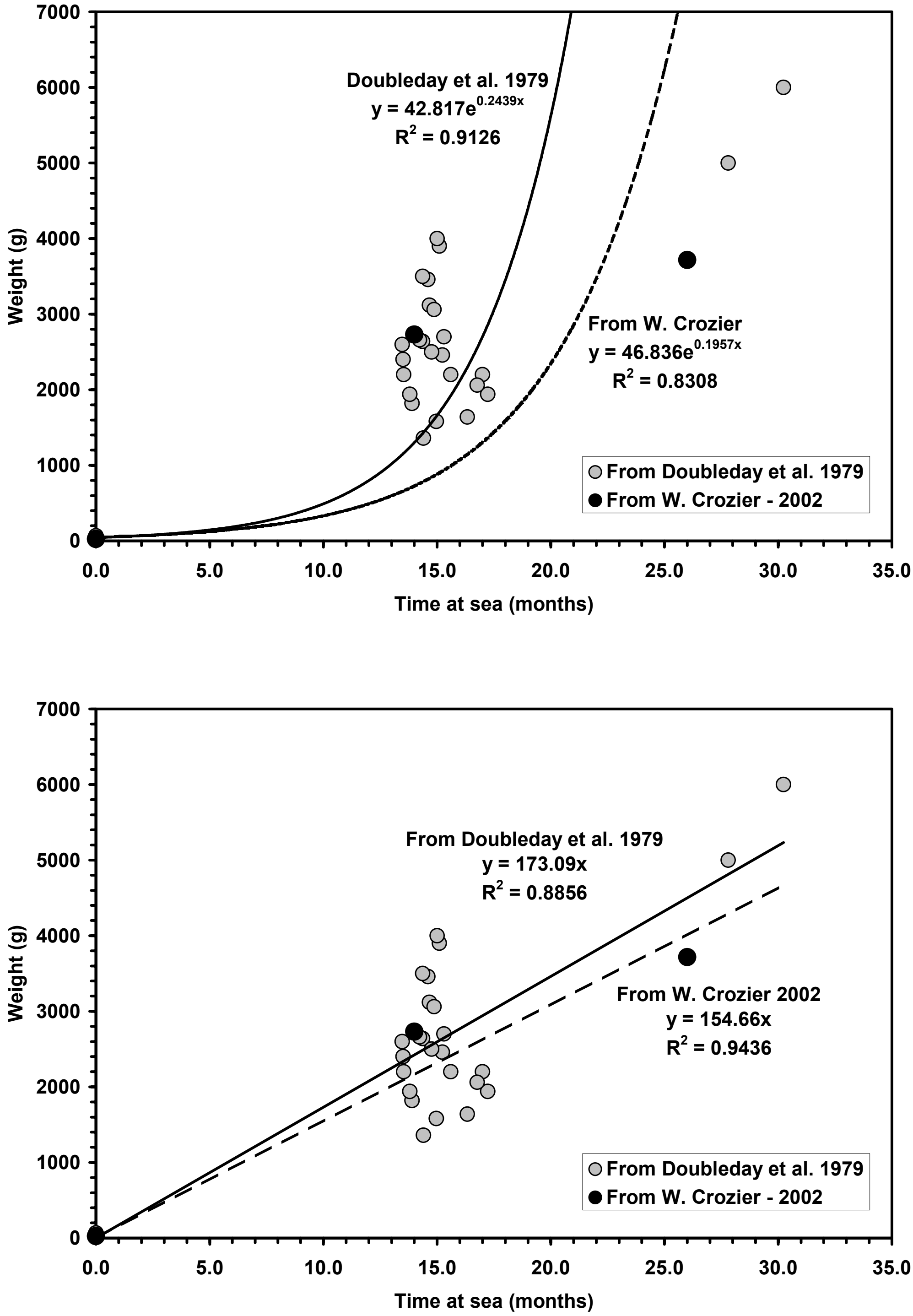


Figure 4.2.1.2 Comparison of weight at sea age (months) data used by Doubleday *et al*. (1979) and newer data provided by W. Crozier (2002) for River Bush salmon. Exponential growth functions are in the upper panel, linear growth functions are in the lower panel.

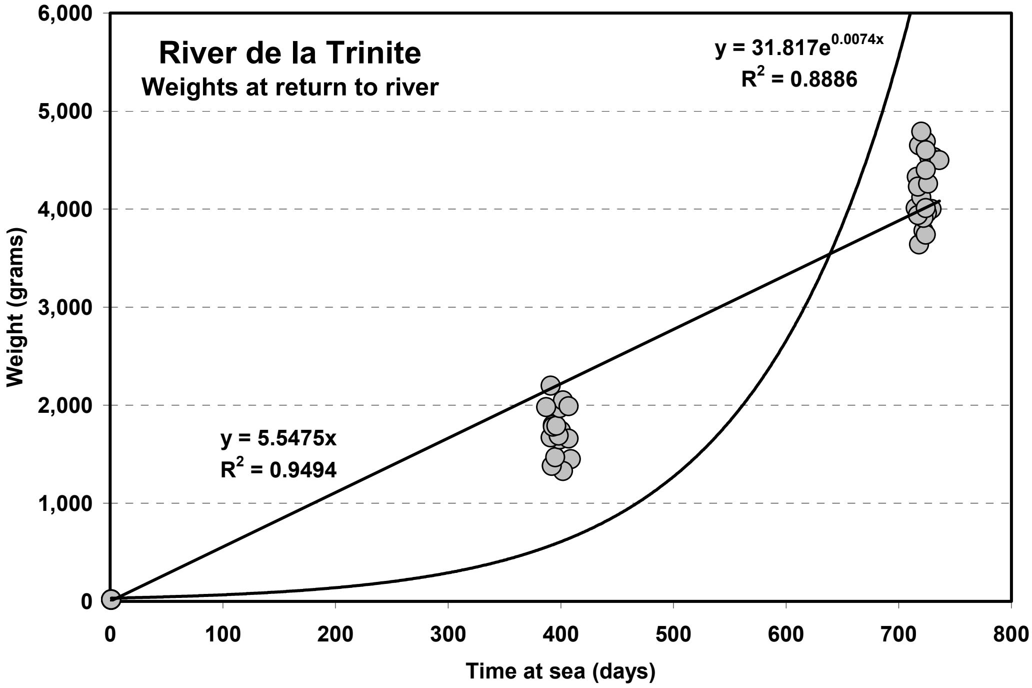
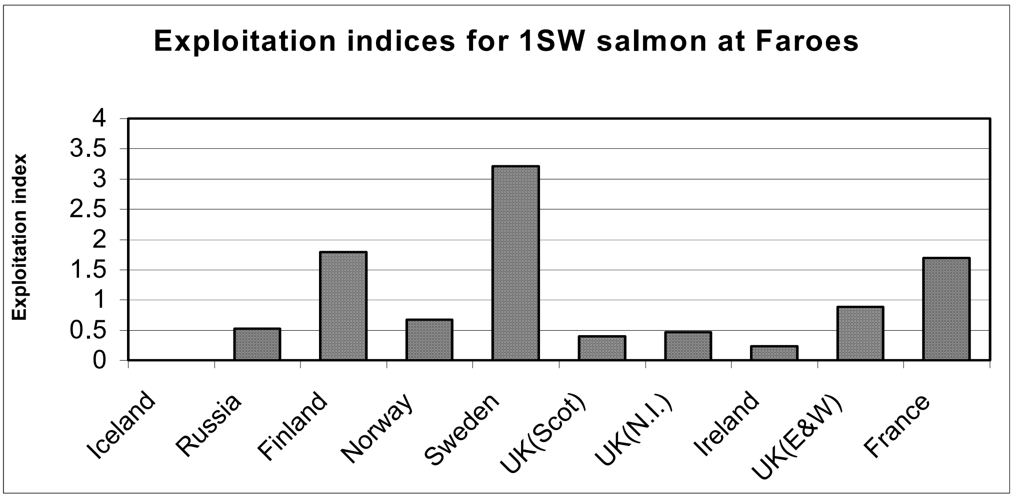
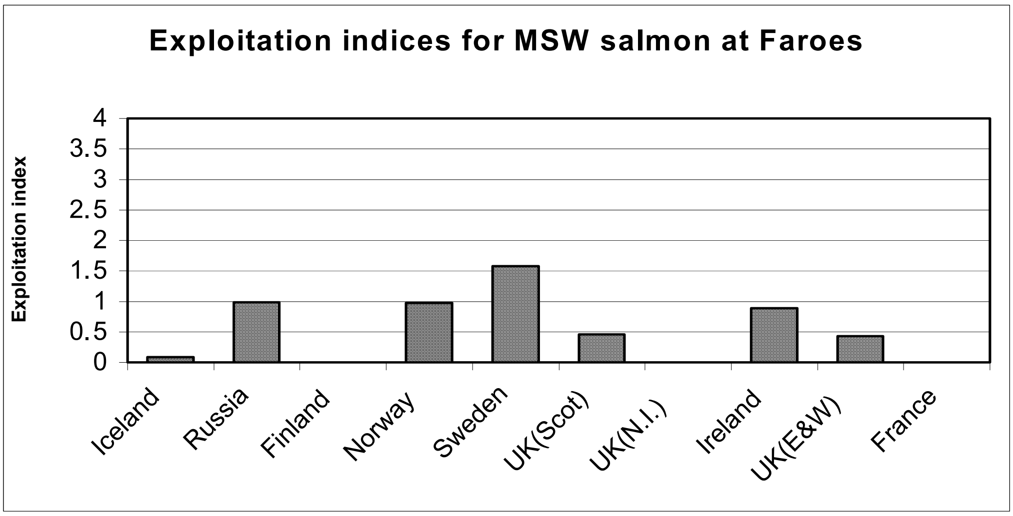


Figure 4.2.1.3 Exponential and linear growth functions applied to the weight at sea age (days) data of Atlantic salmon from the River de la Trinite (Quebec, Canada). Data are average weights of the age group relative to the days at sea since smolt migration. Days at sea are calculated as mean date of return of age group to the river from mean date of smolt migration. Data are from F. Caron (unpubl. data).





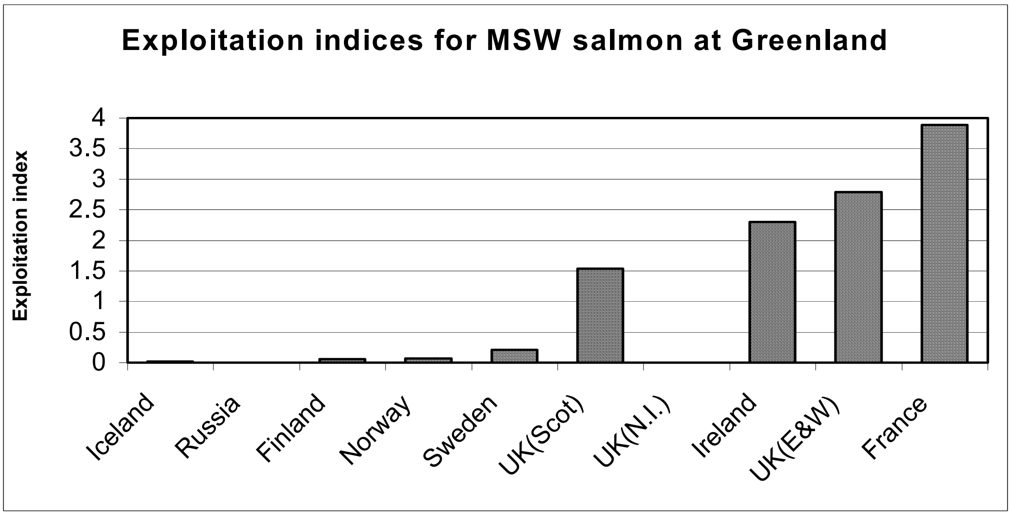


Figure 5.3.1 Exploitation indices for national salmon stocks in the Faroes and West Greenland fisheries.

Input data:		
Year	Stock	Recruits
1975		
1976	1,237,237	1,304,323
1977	1,338,879	1,163,026
1978	1,452,365	1,030,334
1979	1,415,856	972,673
1980	1,083,518	751,420
1981	932,942	495,993
1982	829,527	879,796
1983	741,970	1,326,481
1984	632,291	691,309
1985	448,307	1,329,195
1986	532,079	1,257,963
1987	793,598	894,008
1988	705,670	1,253,827
1989	831,784	725,099
1990	852,781	531,434
1991	754,693	425,903
1992	796,406	597,981
1993	566,035	476,305
1994	463,534	633,216
1995	412,901	599,599
1996	514,821	510,517
1997	398,628	403,938
1998	525,416	441,166
1999		
2000		
2001		
2002		
2003		
2004		
2005		

	Estimate	80%	95%
Conservation limit:	598,838	777,973	1,252,155

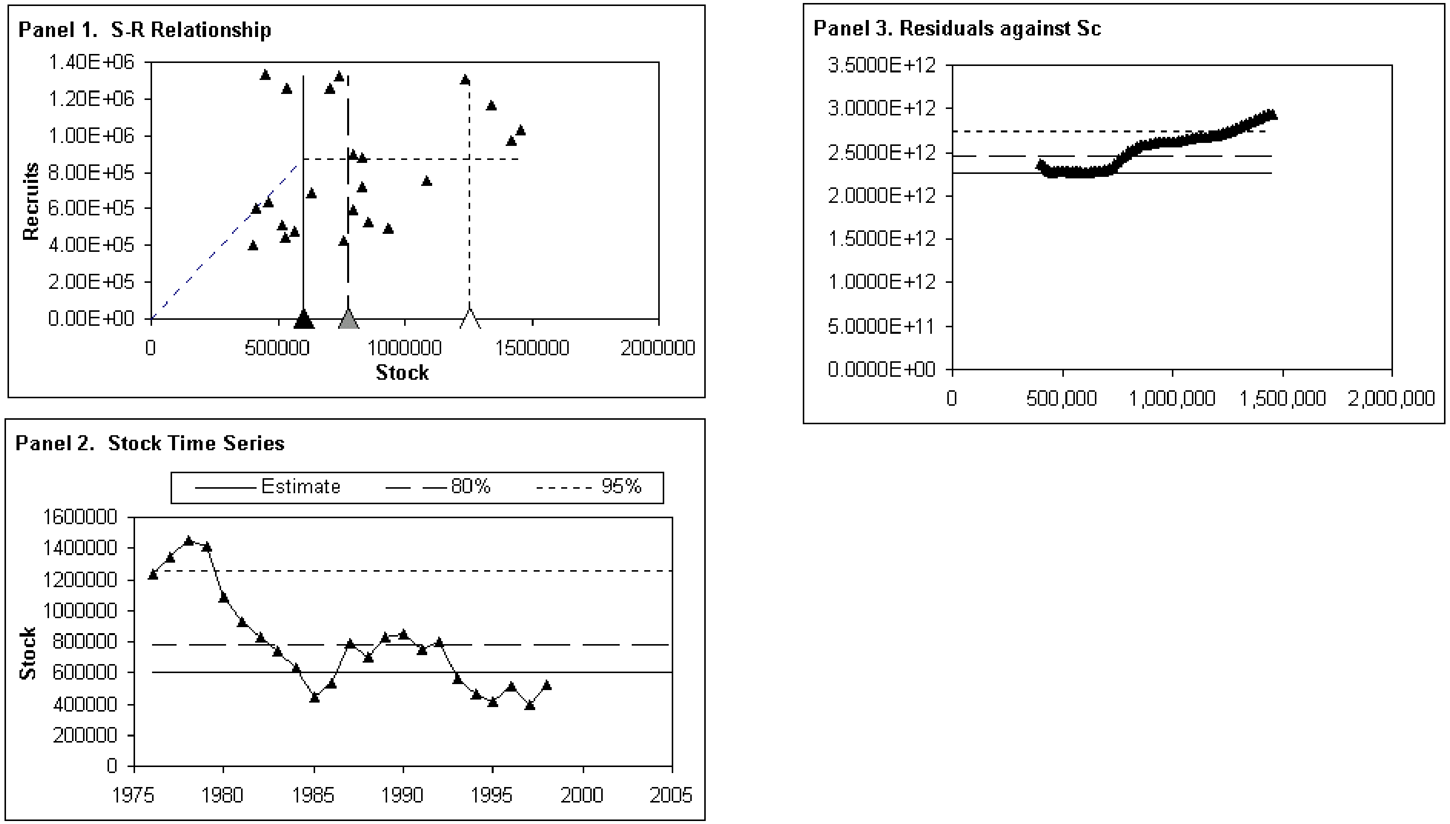


Figure 5.3.2 Estimating reference points from noisy stock-recruitment data.

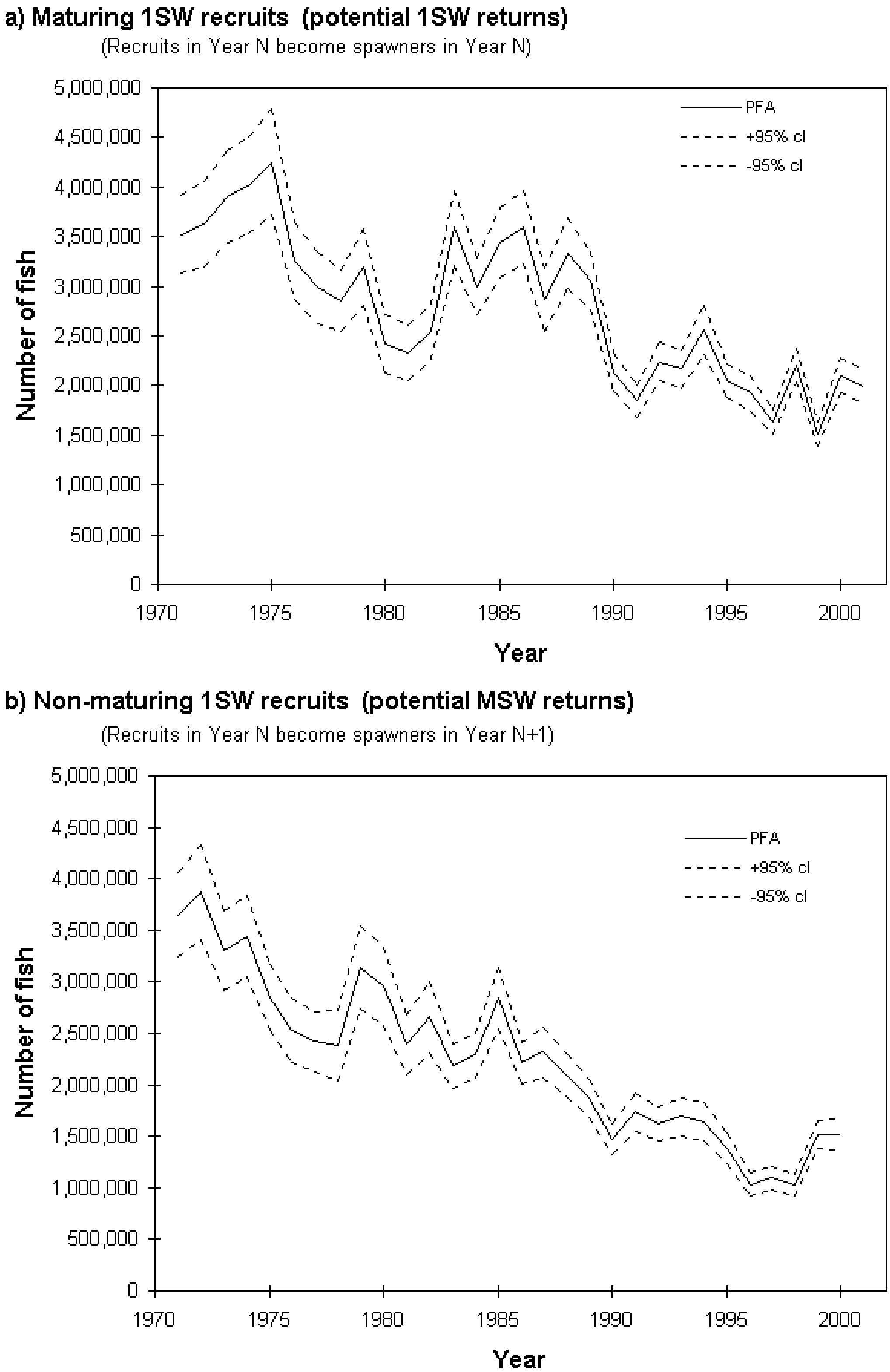
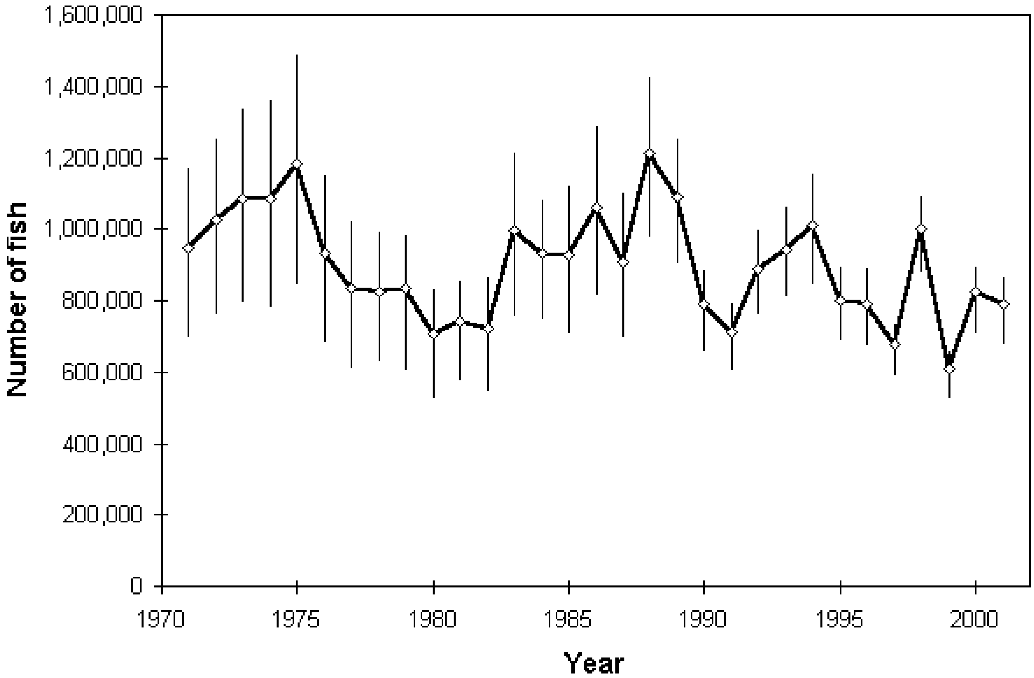


Figure 5.3.3 Estimated recruitment (PFA) in the NEAC area 1970 – 2001.



b) MSW spawners (and 95% confidence limits)

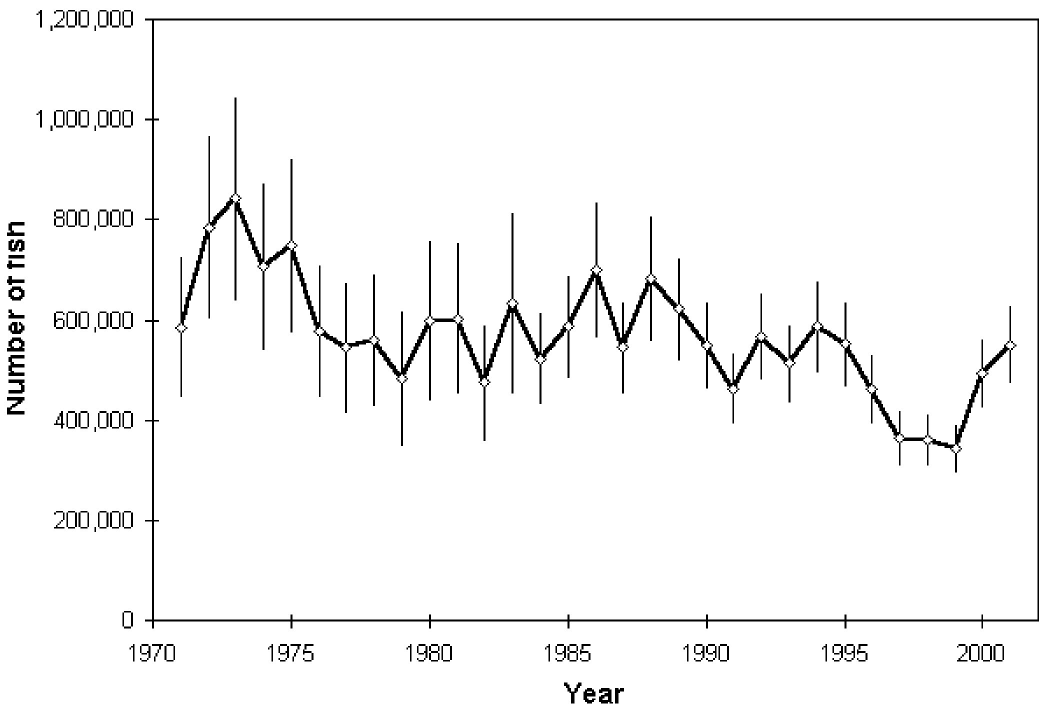


Figure 5.3.4 Estimated spawning escapement in the NEAC area 1970 – 2001.

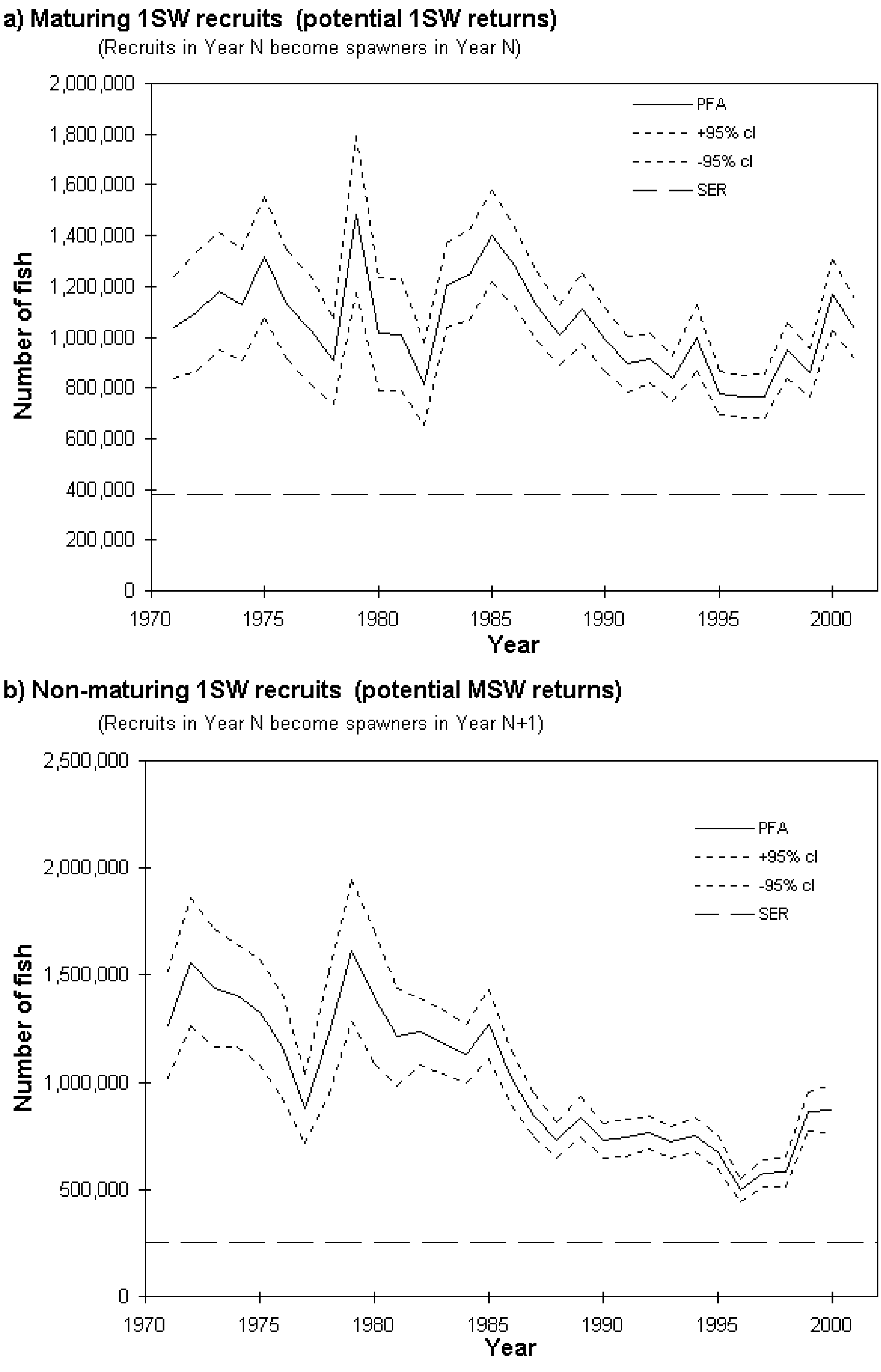
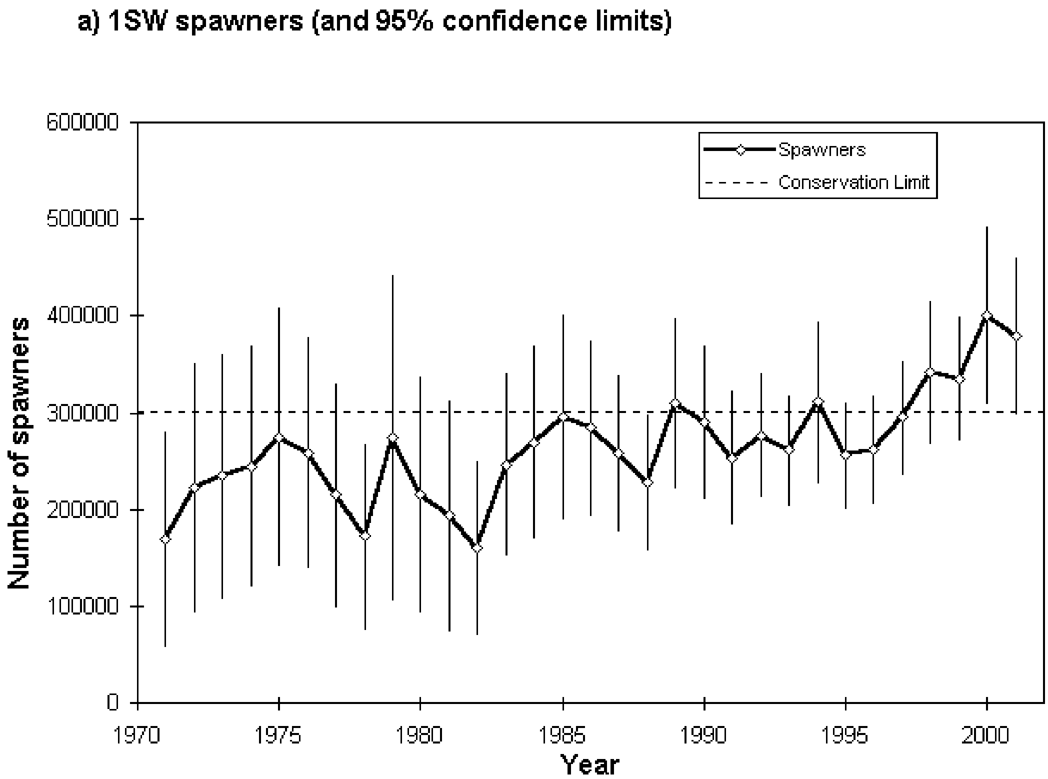


Figure 5.3.5 Estimated recruitment (PFA) and Spawning Escapement Reserve (SER) for maturing and non-maturing salmon in North Europe, 1971 – 2001.



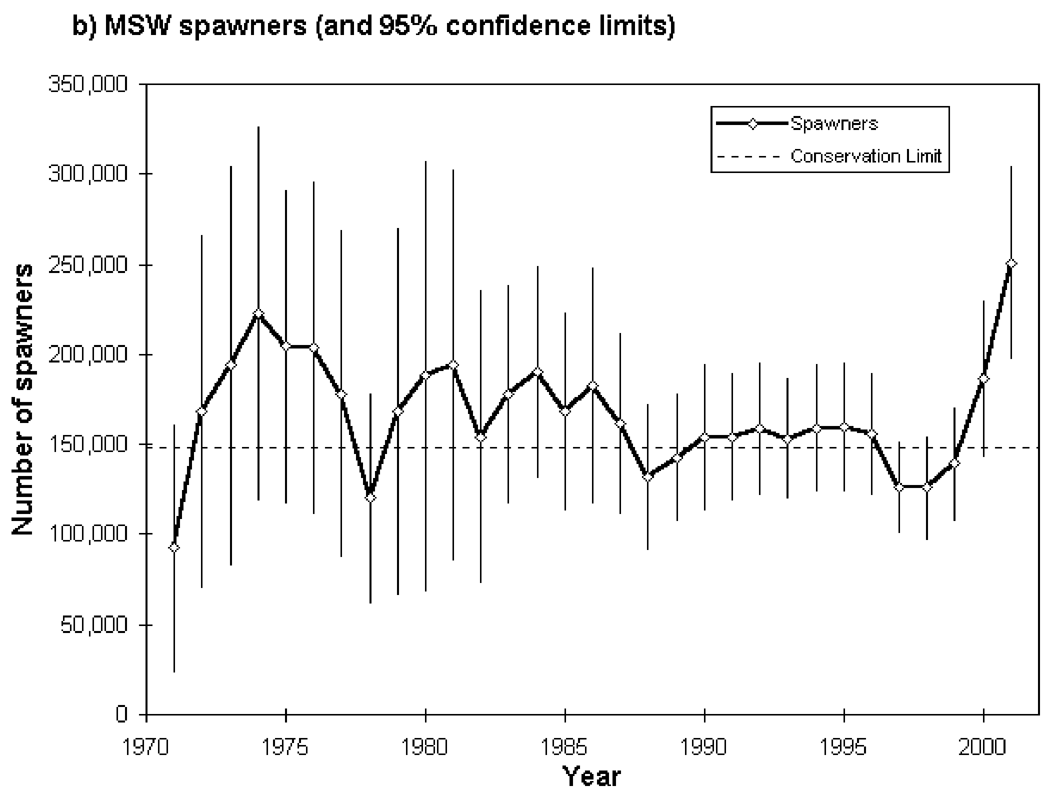


Figure 5.3.6 Estimated spawning escapement of maturing and non-maturing salmon in Northern Europe, 1971–2001.

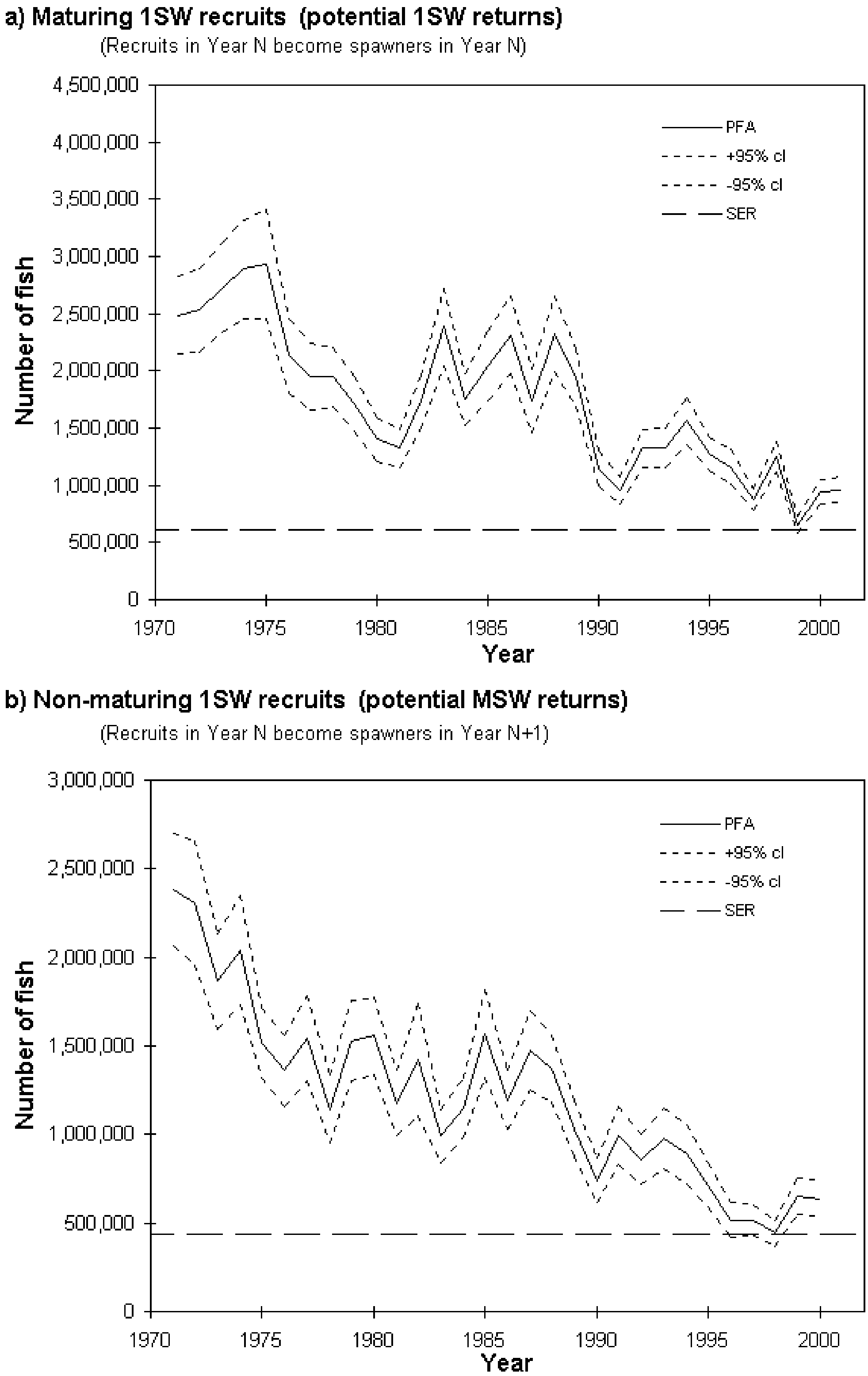


Figure 5.3.7 Estimated recruitment (PFA) and Spawning Escapement Reserve (SER) for maturing and non-maturing salmon in Southern Europe, 1971–2001.

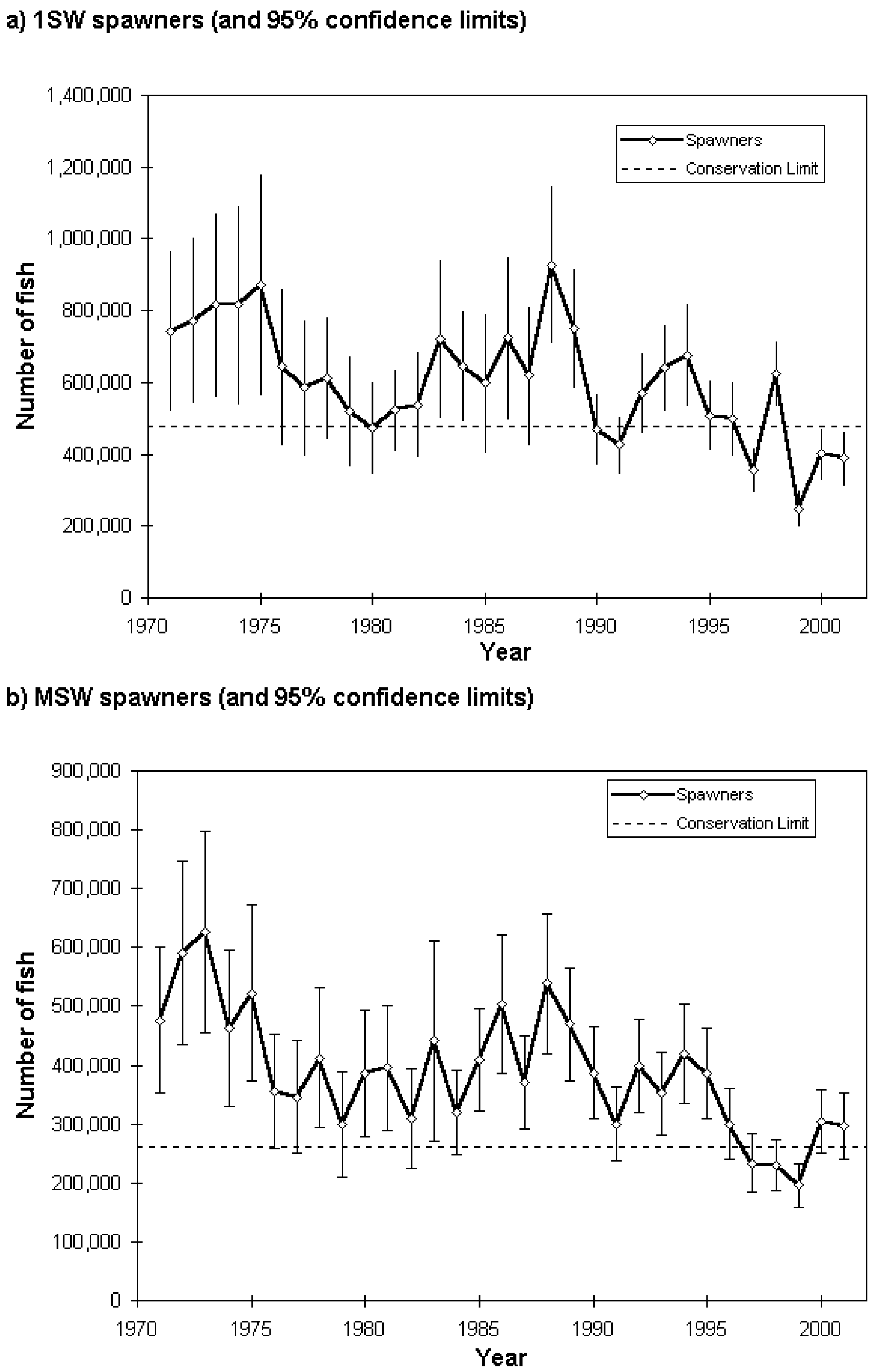


Figure 5.3.8 Estimated spawning escapement of maturing and non-maturing salmon in Southern Europe, 1971-2001.

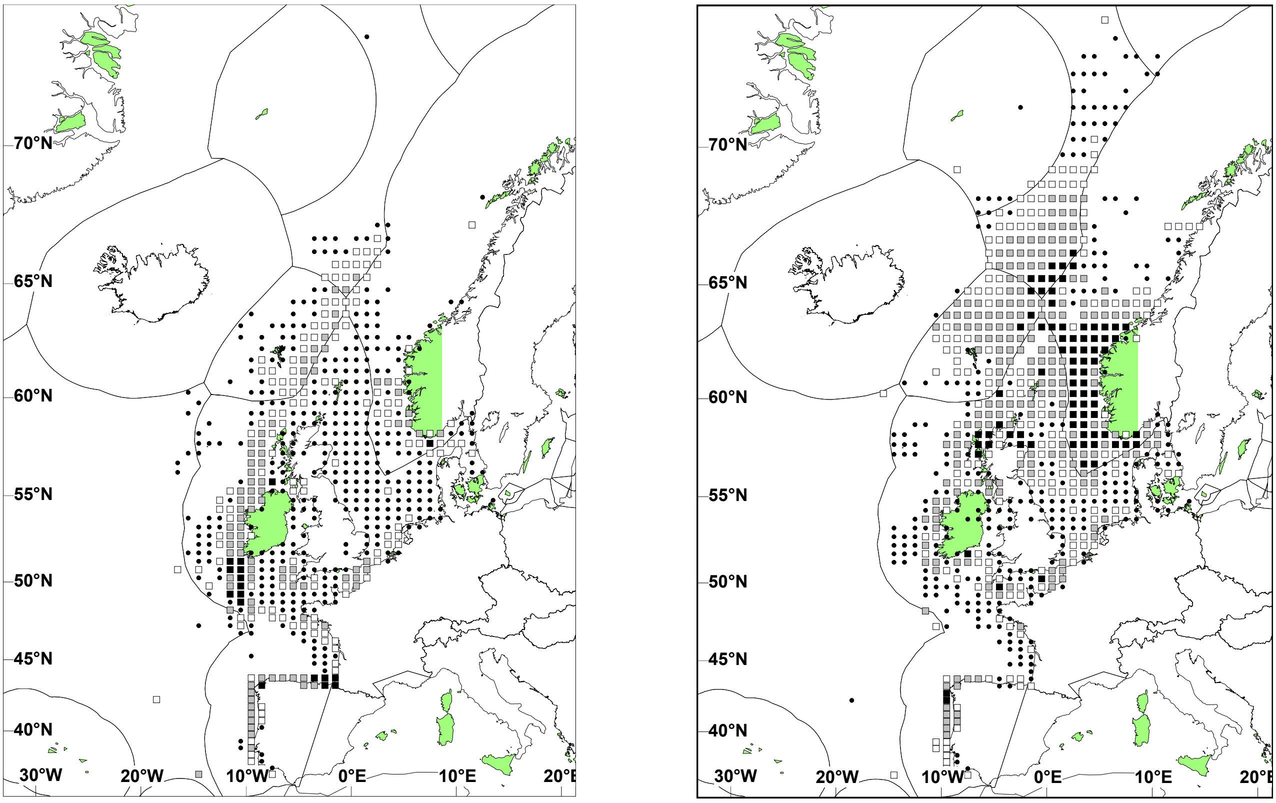


Figure 5.3.11 Distribution of the total mackerel catches 1977–2000 by statistical rectangle in 2nd (left) and 3rd (right) quarter (from ICES 2002/G:03).

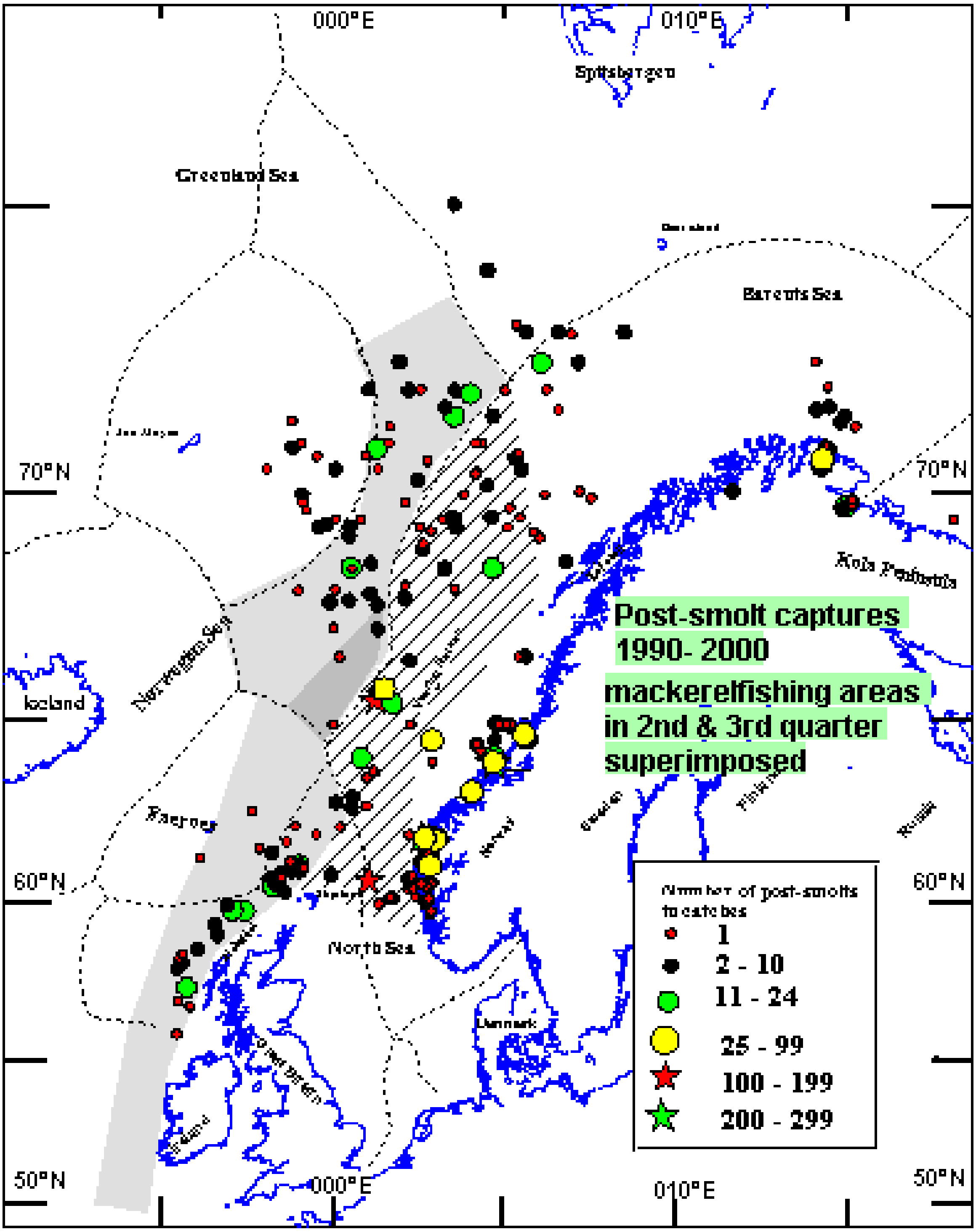


Figure 5.3.12. Post-smolt captures in pelagic surveys 1990–2000. Post-smolt legends in figure. Mackerel fishing areas 1977–2000 are superimposed as a shaded area. The highest trawl captures occurred in international areas close to the Norwegian EEZ. Norwegian purse seine capture areas are hatched.

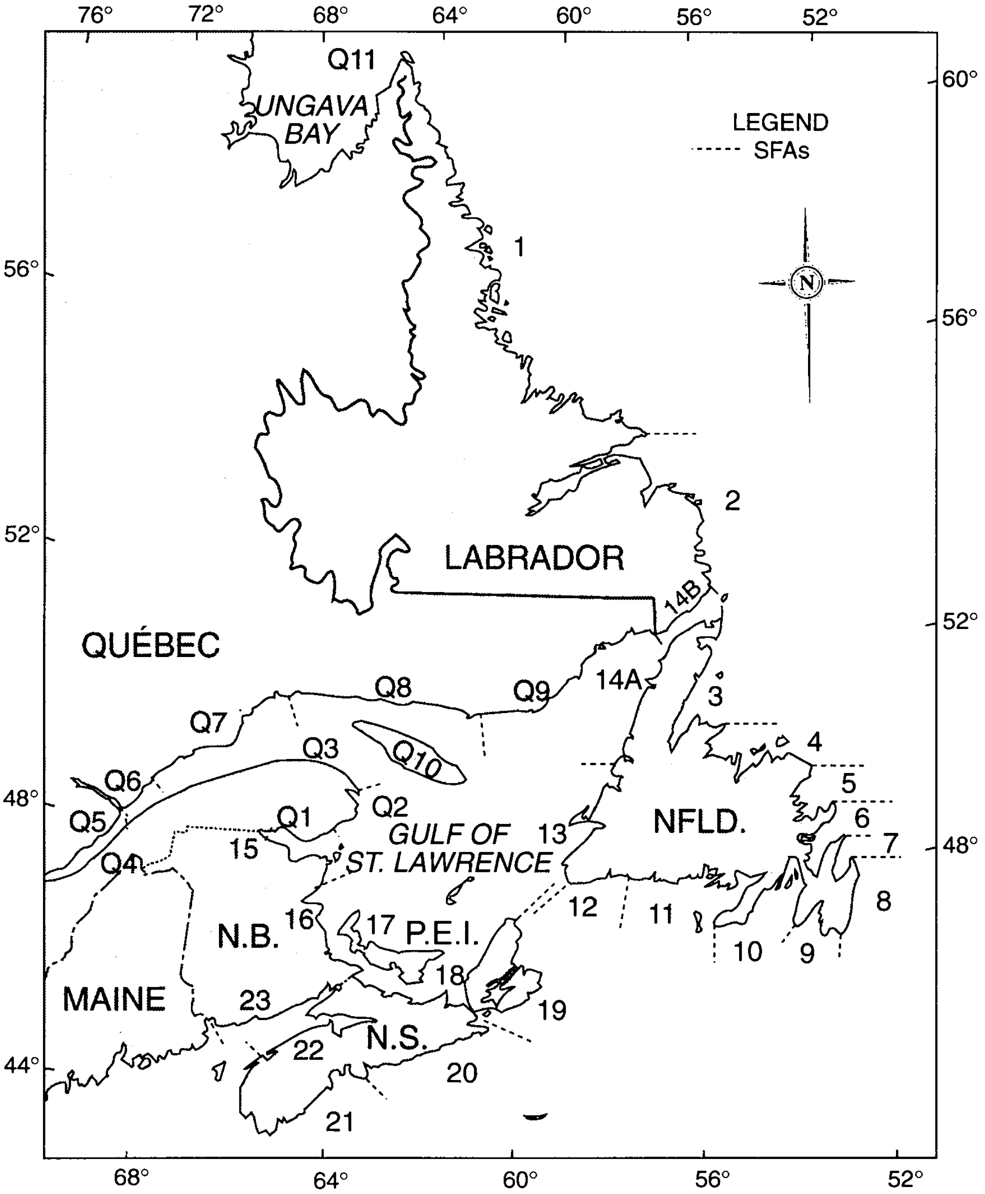


Figure 6.1.1.1 Map of Salmon Fishing Areas (SFAs) and Quebec Management Zones (Qs) in Canada.

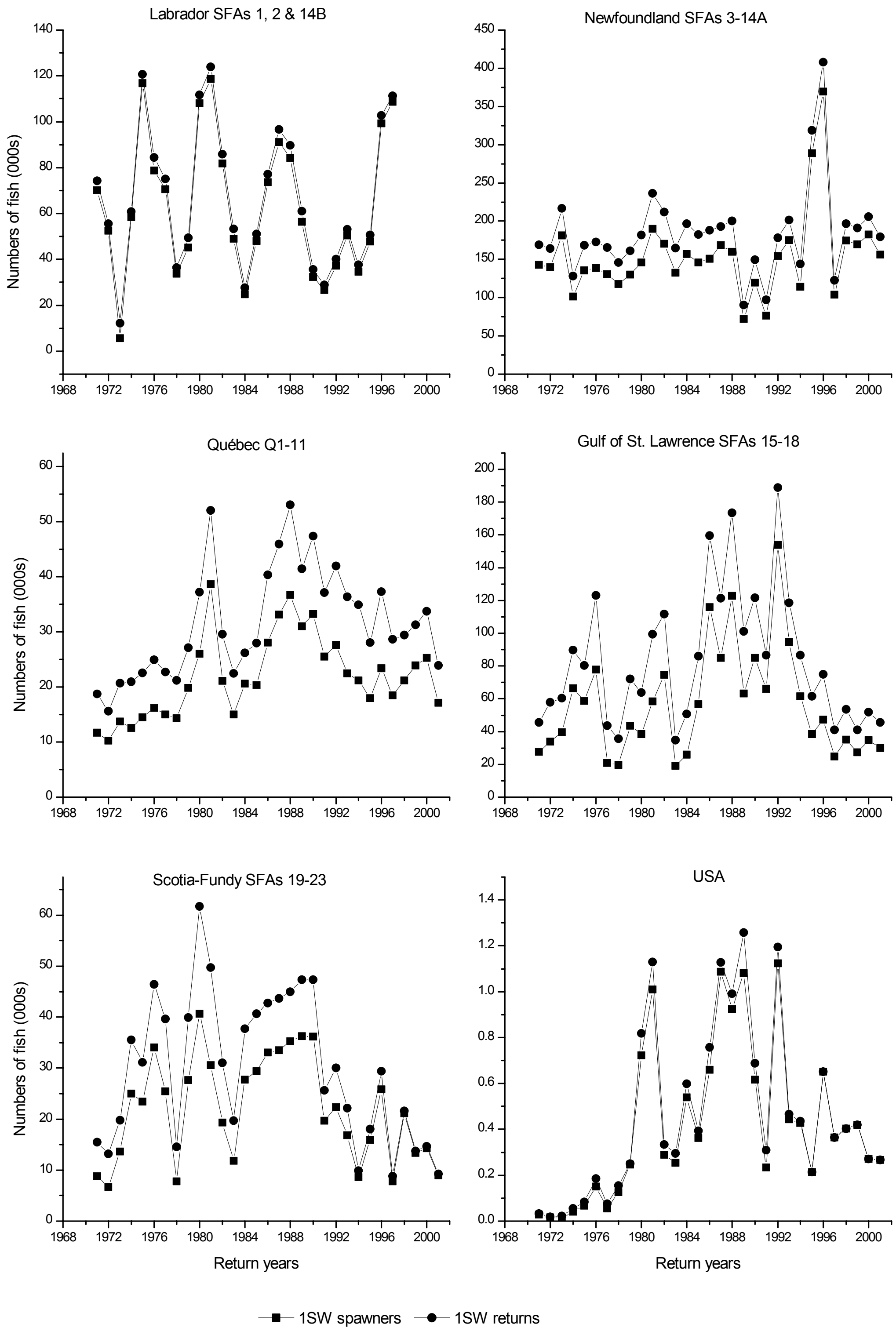
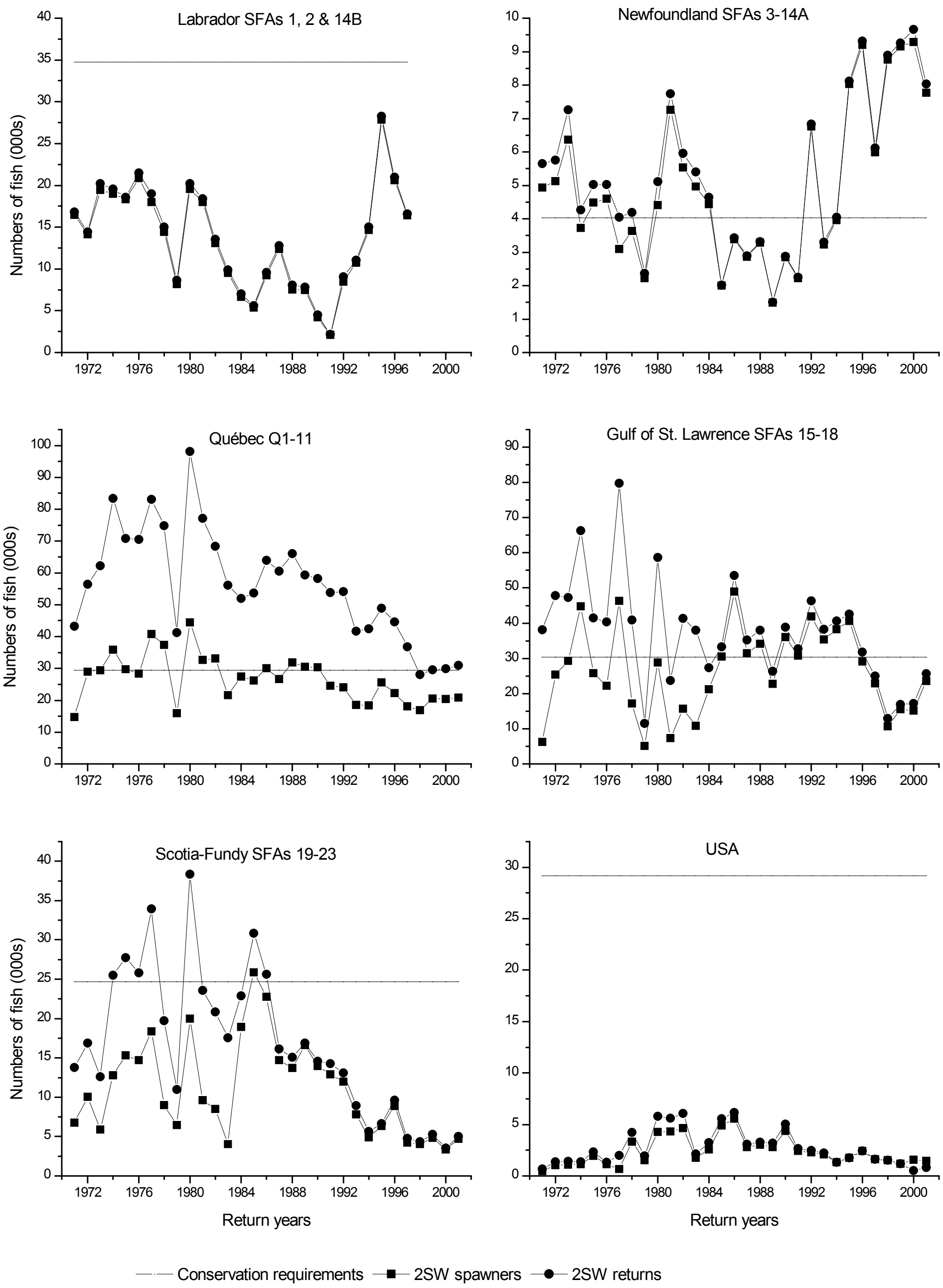


Figure 6.1.2.1 Comparison of estimated mid-points of 1SW returns to and 1SW spawners in rivers of six geographic areas in North America. Returns and spawners for Scotia-Fundy do not include those from SFA 22 and a portion of SFA 23.



Labrador SFAs 1, 2 & 14B
Newfoundland SFAs 3-14A
Québec Q1-11
Gulf of St. Lawrence SFAs 15-18
Scotia-Fundy SFAs 19-23
USA
Numbers of fish (000s)
Return years
Conservation requirements
2SW spawners
2SW returns

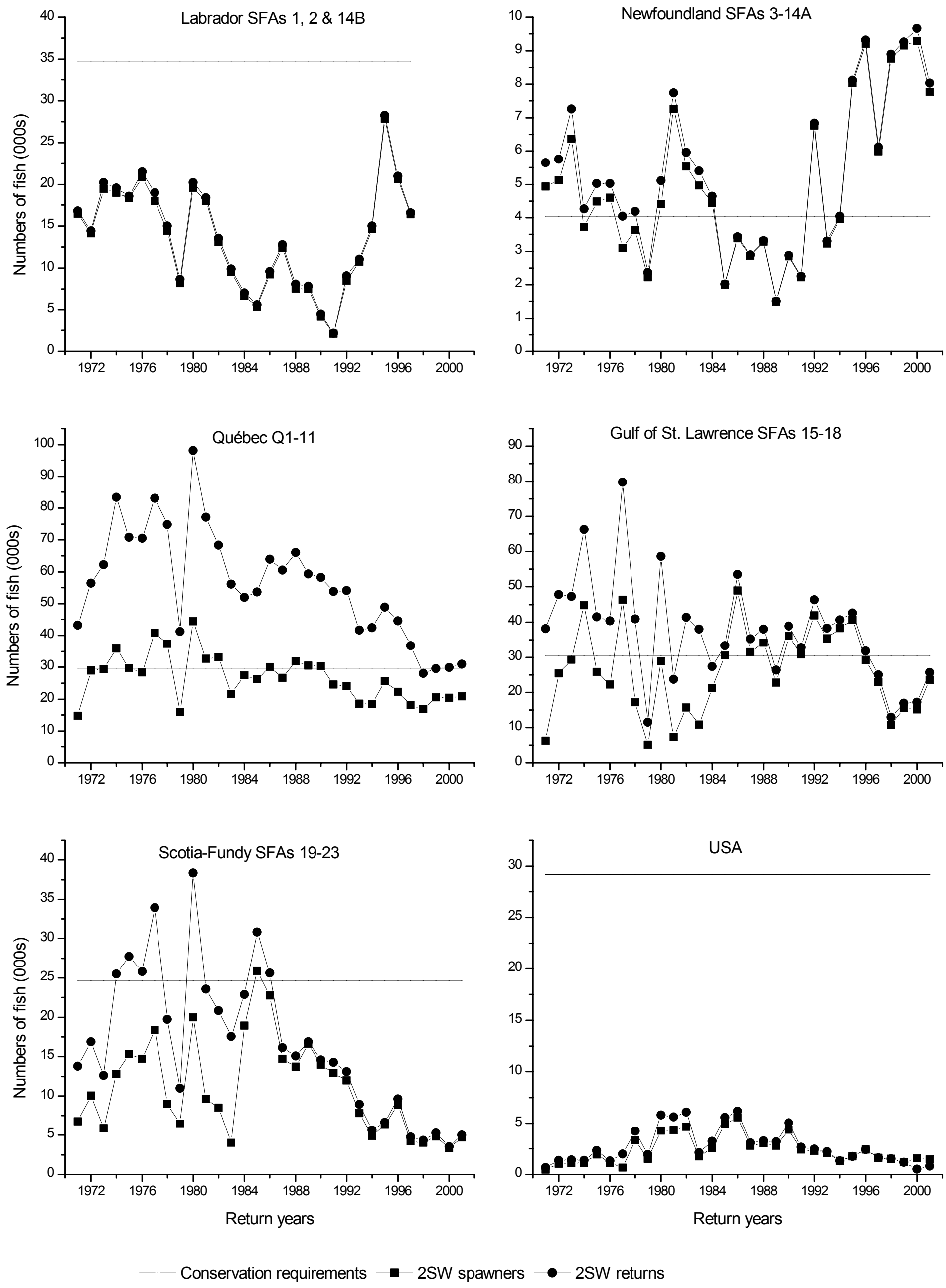


Figure 6.1.2.2 Comparison of estimated mid-points of 2SW returns, 2SW spawners, and 2SW conservation limits for six geographic areas in North America. Returns and spawners for Scotia-Fundy do not include those from SFA 22 and portion of SFA 23.

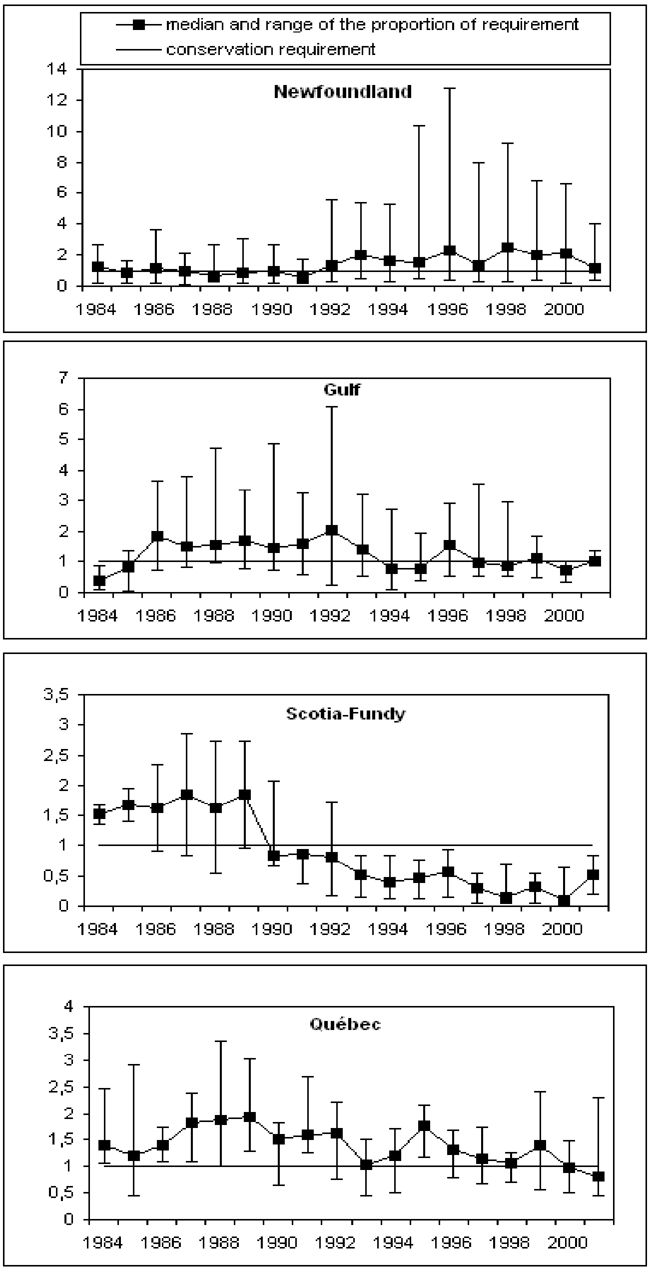


Figure 6.1.2.3 Proportion of the conservation limits met in monitored rivers in four geographic areas of eastern Canada, 1984 to 2001. The vertical line represents the minimum and maximum proportion achieved in individual rivers, the black square is the median proportion. The range of the number of rivers included in the annual summary was 7–8 for Newfoundland, 3–8 for the Gulf, 2–3 for Scotia-Fundy and 9 for Québec.

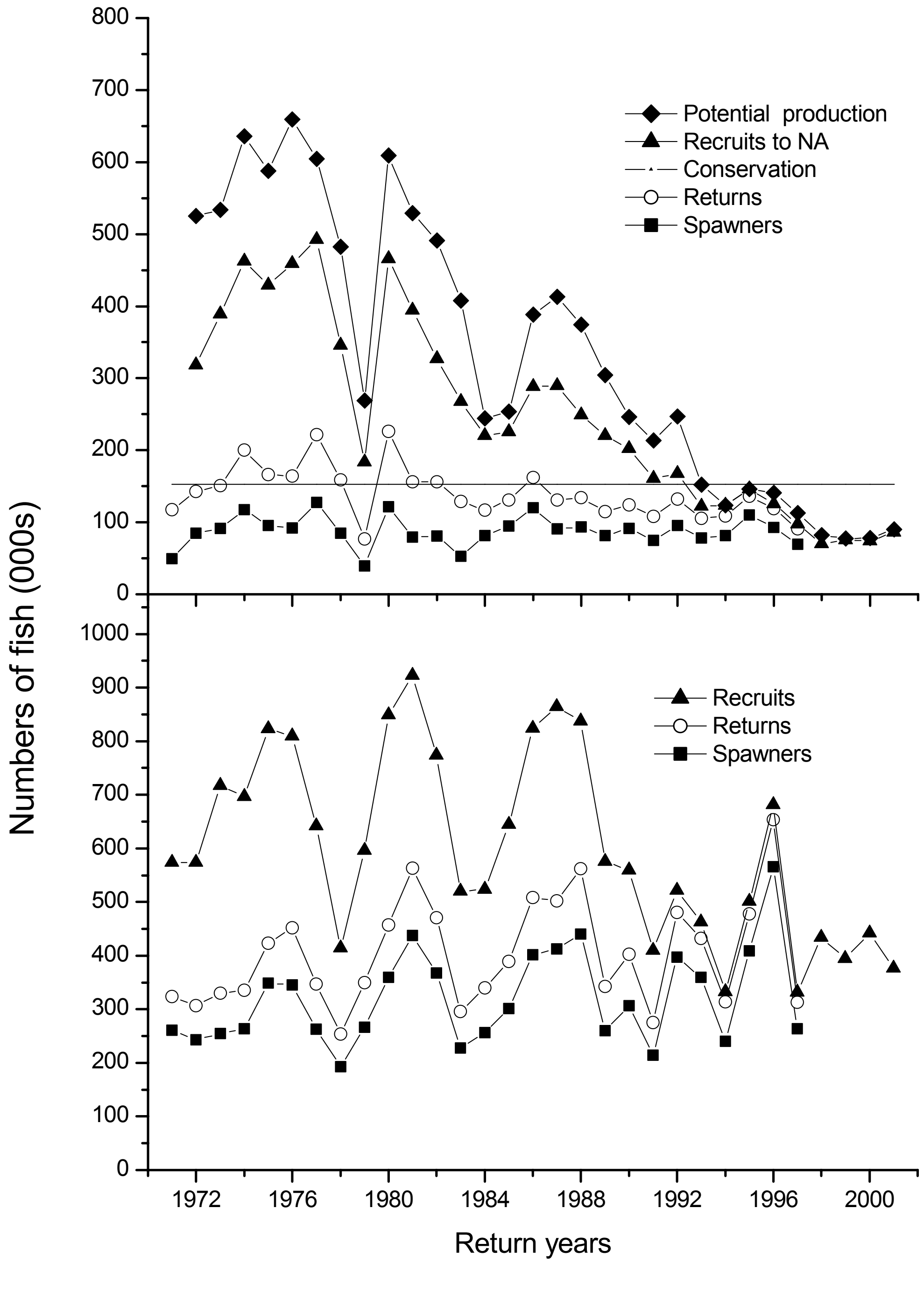


Figure 6.1.2.4 Top panel: comparison of estimated potential 2SW production prior to all fisheries, 2SW recruits available to North America, 1971–2001 and 2SW returns and spawners for 1971–1997, as 1998–2001 data for Labrador are unavailable. The horizontal line indicates the 2SW conservation limits. Bottom panel: comparison of potential maturing 1SW recruits, 1971–2001 and returns and 1SW spawners for 1971–1997 return years as Labrador data for 1998–2001 are unavailable.

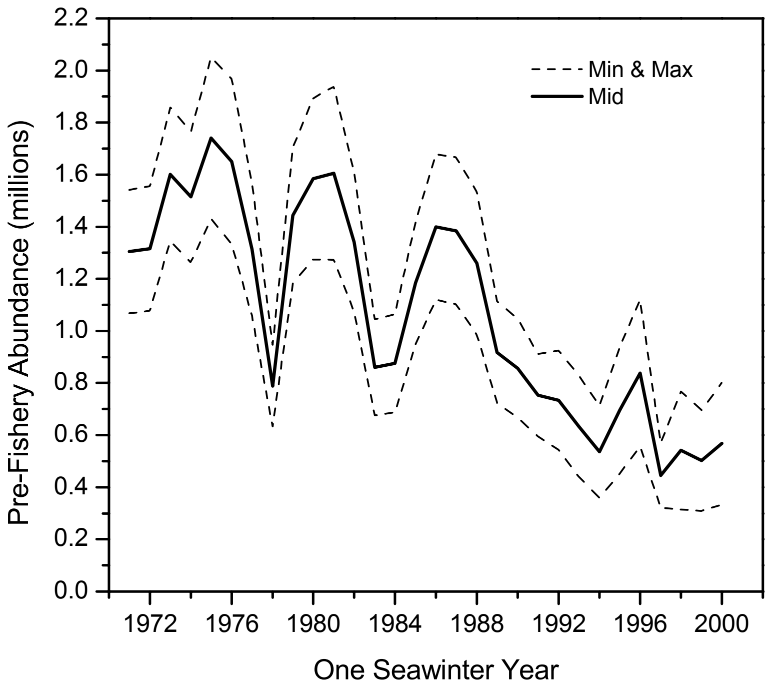


Figure. 6.1.2.5 Total 1SW recruits (non-maturing and maturing) originating in North America.

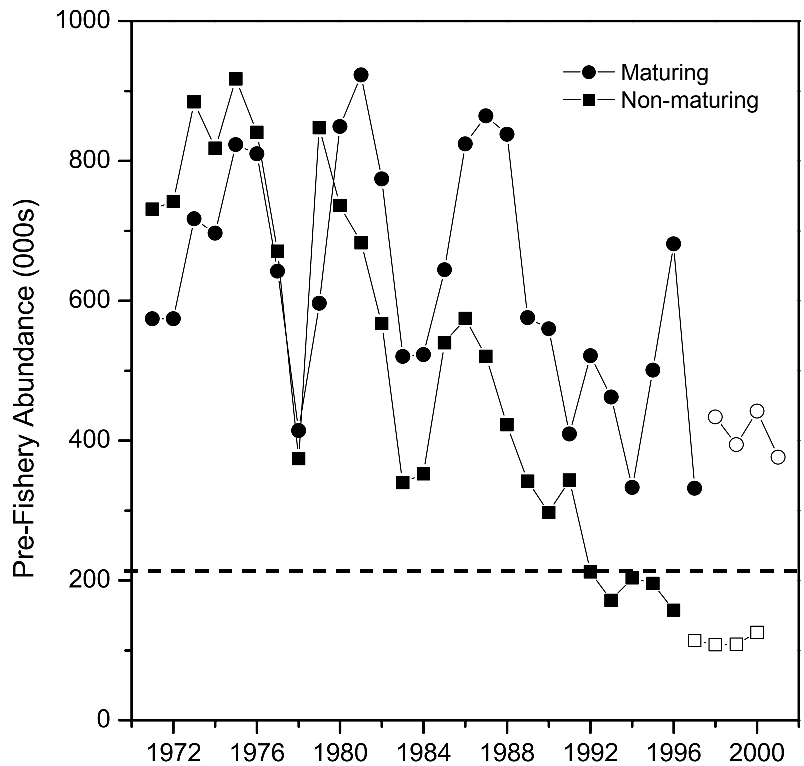


Figure 6.1.2.6 Prefishery abundance estimate of maturing and non-maturing salmon in North America. Open circles are for the years that returns to Labrador were assumed as a proportion of returns to other areas in North America. The dashed line represents the spawning escapement reserve of 212, 189 non-maturing pre-fishery abundance fish salmon.

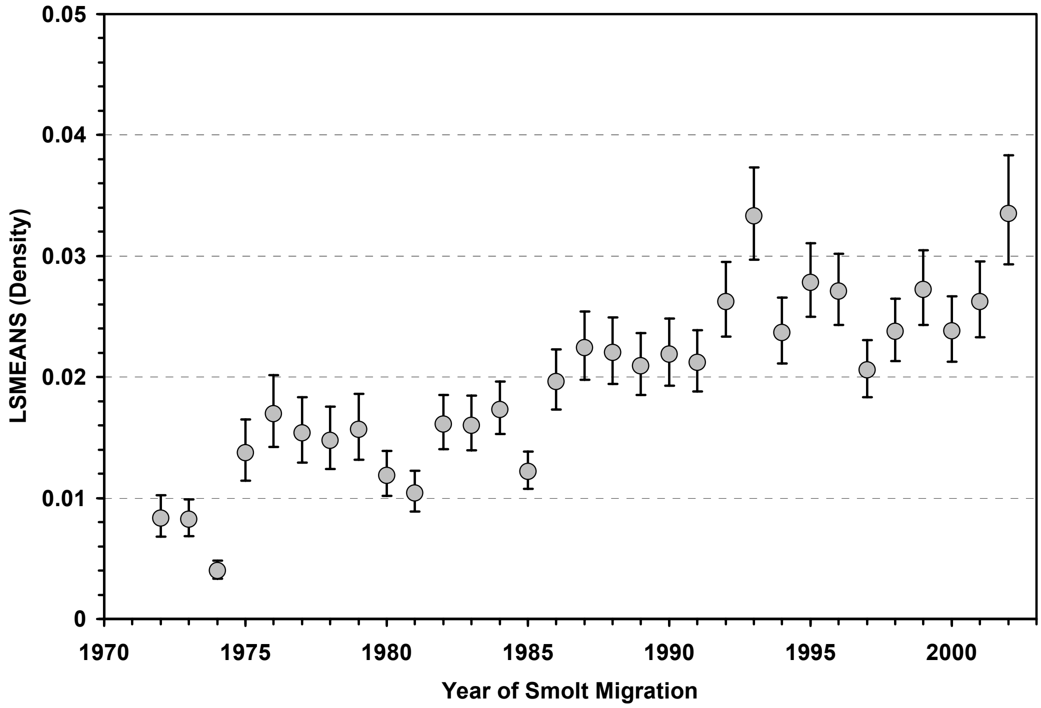


Figure 6.1.2.7 Relative index of smolt production in eastern North America. The index was derived from juvenile and smolt surveys in rivers of eastern Canada. The circle is the model adjusted mean (salmon fishing area factor) and the t-bars show one standard deviation range. Juvenile and smolt data were natural ln transformed before analysis. The individual river indices were weighted by the 2SW spawner requirement for their respective salmon fishing areas.

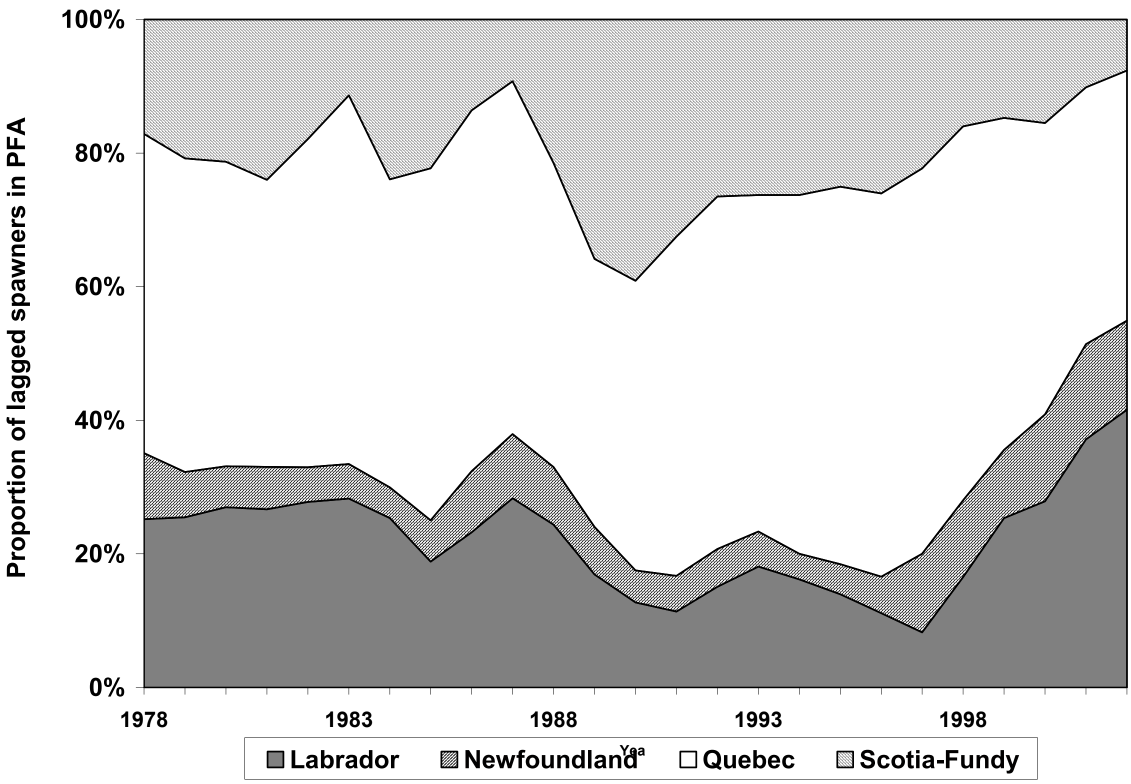


Figure 6.4.1 Proportional contribution of four salmon production regions to the lagged numbers of spawning salmon contributing to the estimate of the pre-fishery abundance of maturing two-sea-winter Atlantic salmon in the North Atlantic 1978 to 2002.

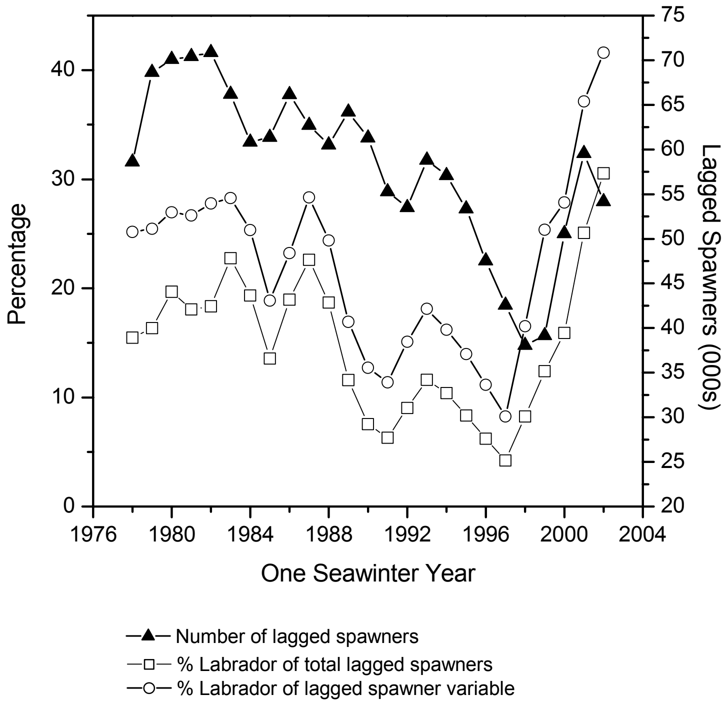


Figure 6.4.2 The lagged spawner variable used to forecast pre-fishery abundance and its relationship to the total number of lagged spawners in North America and and the Labrador component.

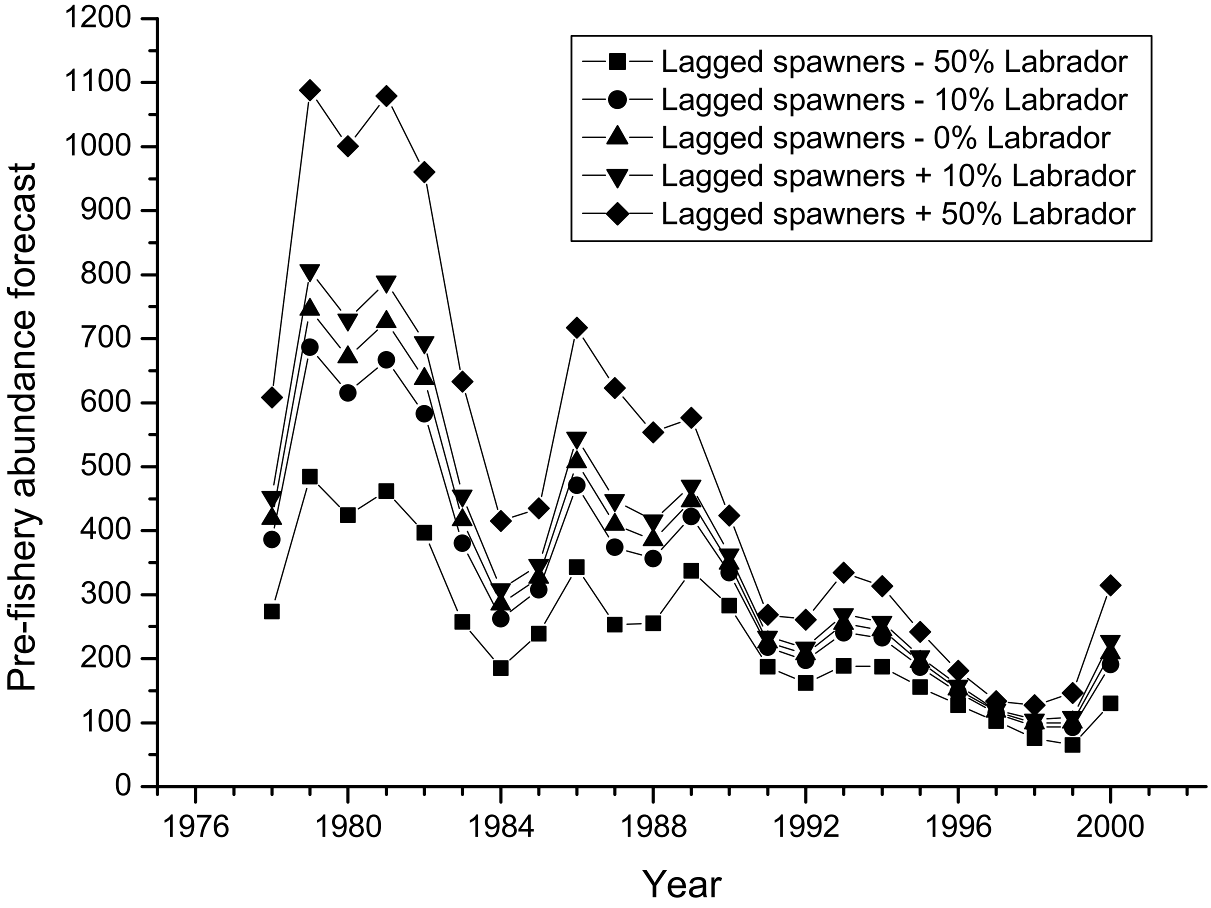


Figure 6.4.3 An examination of the sensitivity of the lagged spawner variable to changes in its Labrador component evaluated at variations of 0%, ±10% and ±50%.

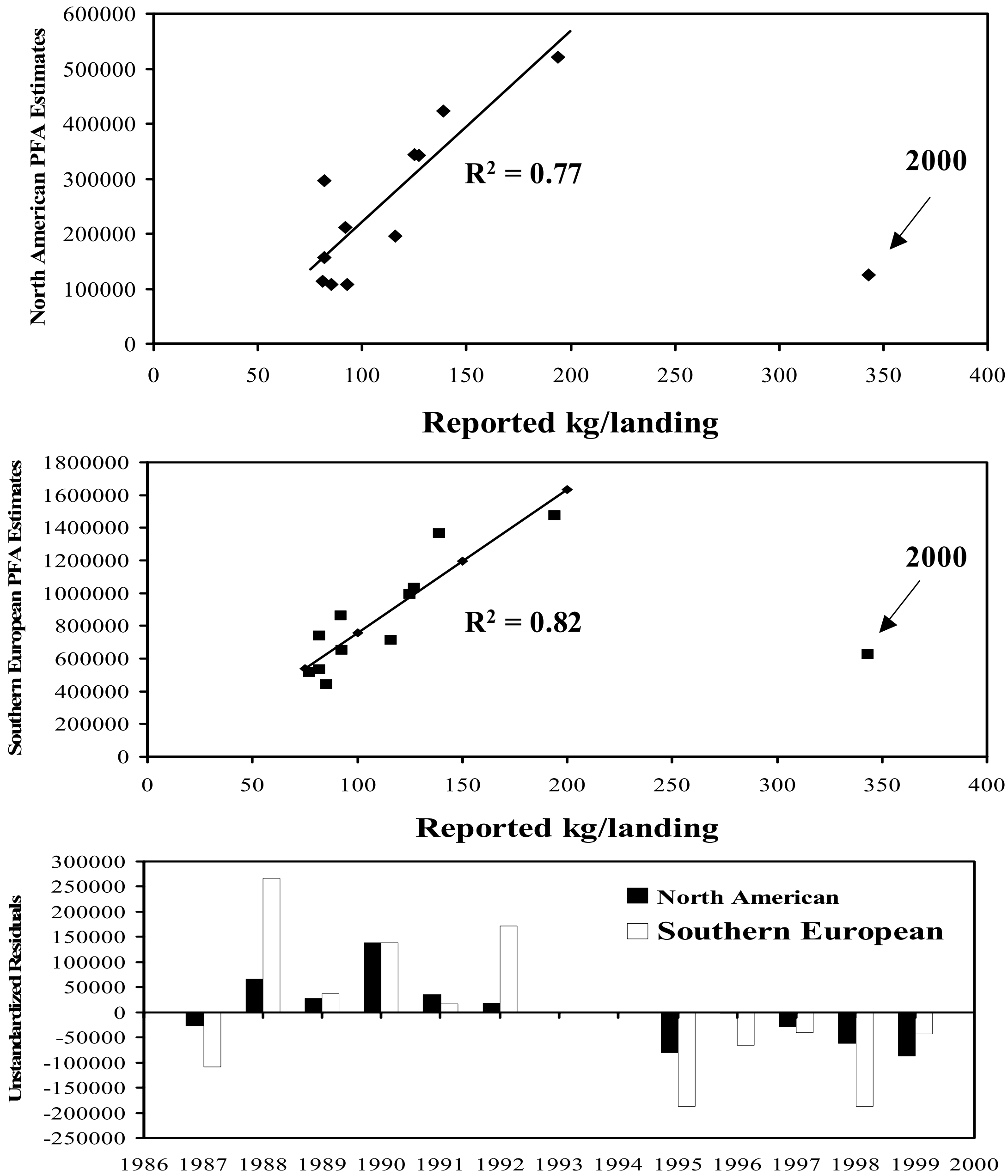


Figure 7.1.2.1 Relationship of CPUE and prefishery abundance estimates for the non-maturing 1SW component of the North American (top panel) and Southern European stock complex (middle panel). Input data have been updated with revised PFA values and CPUE data are slightly different than those available at the 2002 NASCO meeting. Regression relationships exclude the outlying point for 2000, and residuals from both regressions are shown in the bottom panel.

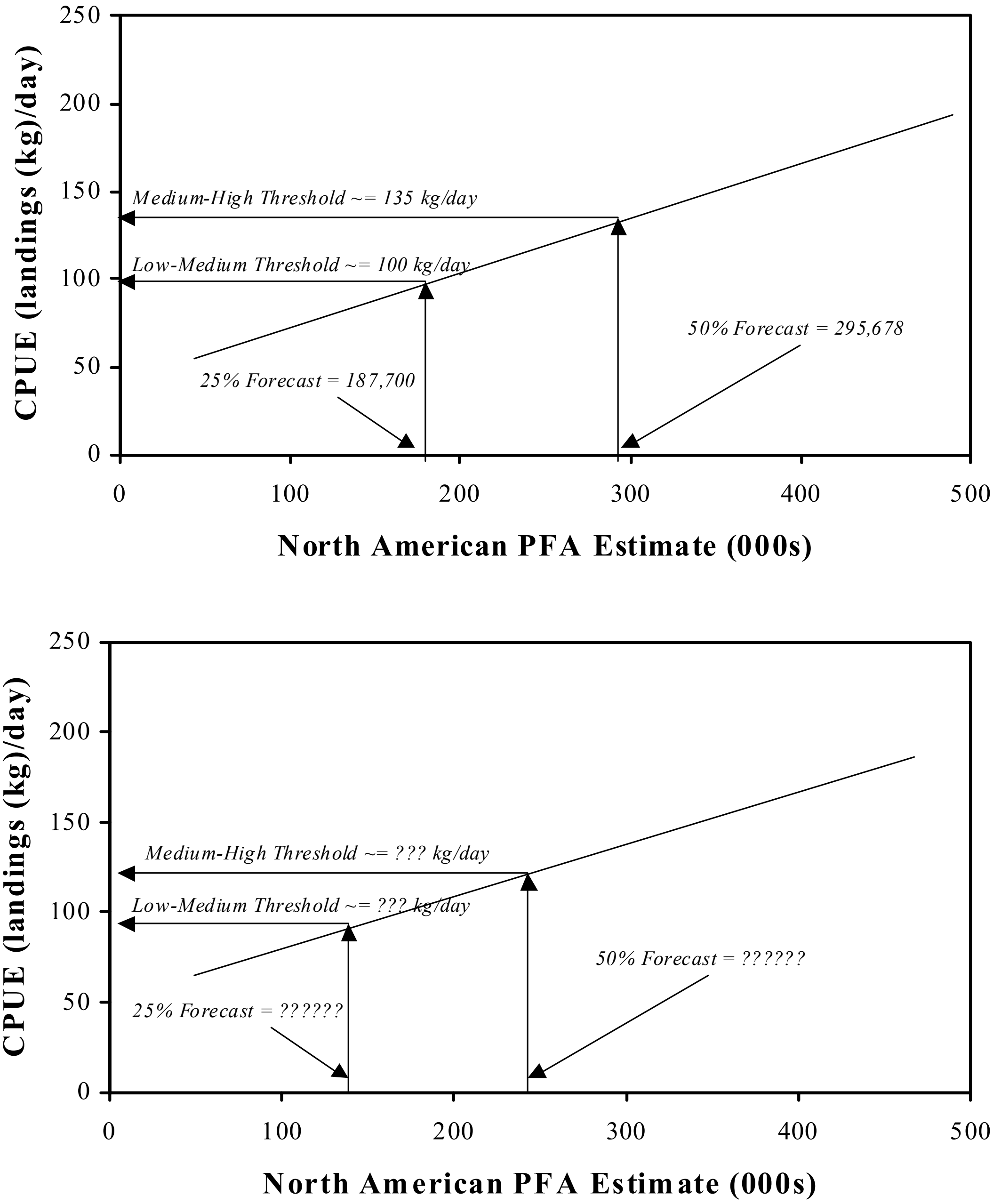


Figure 7.1.2.2. Illustration of method used to establish CPUE thresholds for the 2001 ad hoc management system, which included 1) regressing CPUE against the PFA estimates, 2) using the resulting relationship to estimate the CPUE associated with the 25% and 50% probability levels of the PFA forecasts to use as thresholds between the low, medium and high CPUE zones. Bottom panel provides an example of how threshold levels could change as a result of revised PFA estimates, and a different probability distribution of PFA estimates.

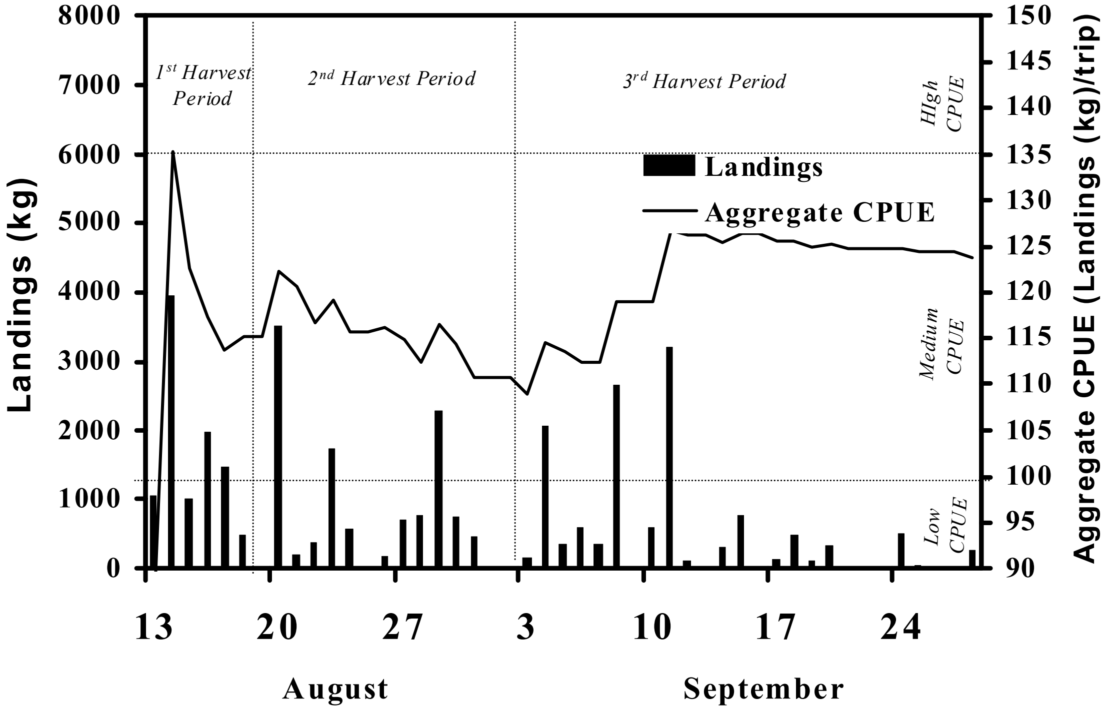


Figure 7.1.2.3 Daily landings and aggregated catch per unit effort (kg/landing) during the 2001 fishery relative to harvest periods and CPUE thresholds established for quota allocation decisions.

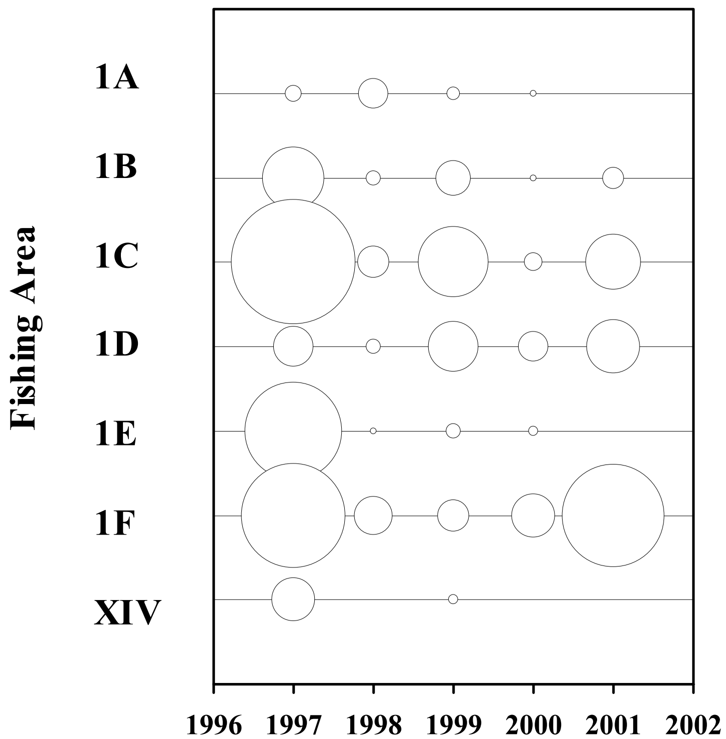


Figure 7.1.2.4. Distribution of commercial effort (number of trips reporting salmon landings) by NAFO area in the fisheries at West (regions 1A to 1F) and East Greenland fisheries from 1997 to 2001. The size of circles indicates the number of commercial trips reported in each year and area.

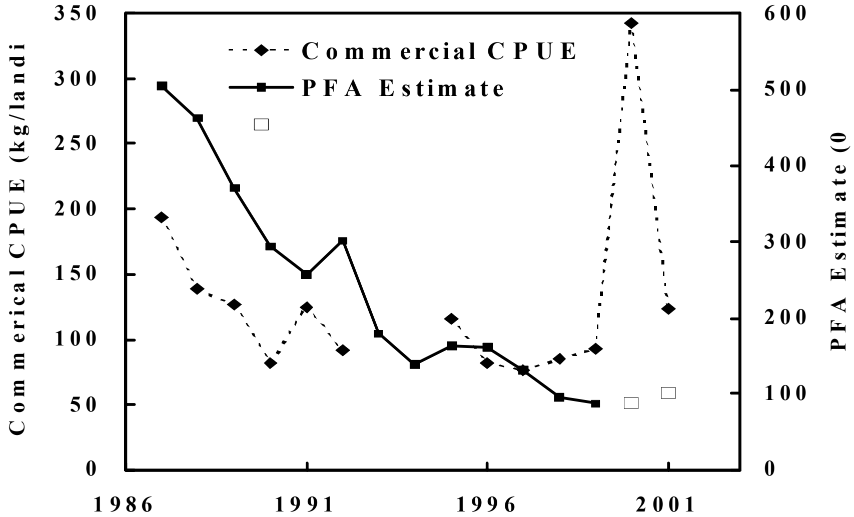


Figure 7.1.2.5. Relationship of CPUE and prefishery abundance estimates and forecasts for the non-maturing 1SW component of the North American Atlantic Salmon stock complex using PFA estimates updated in 2002.

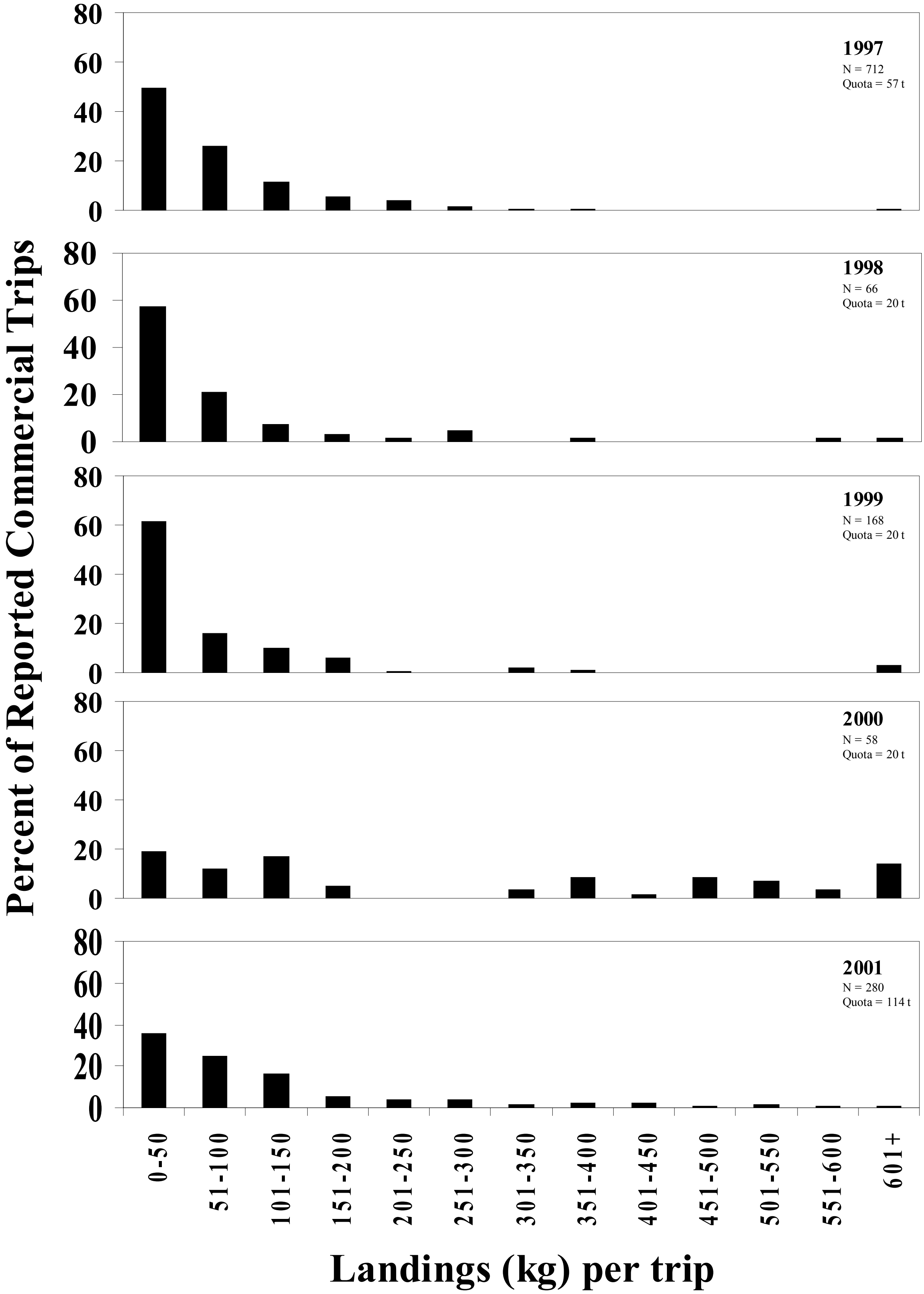
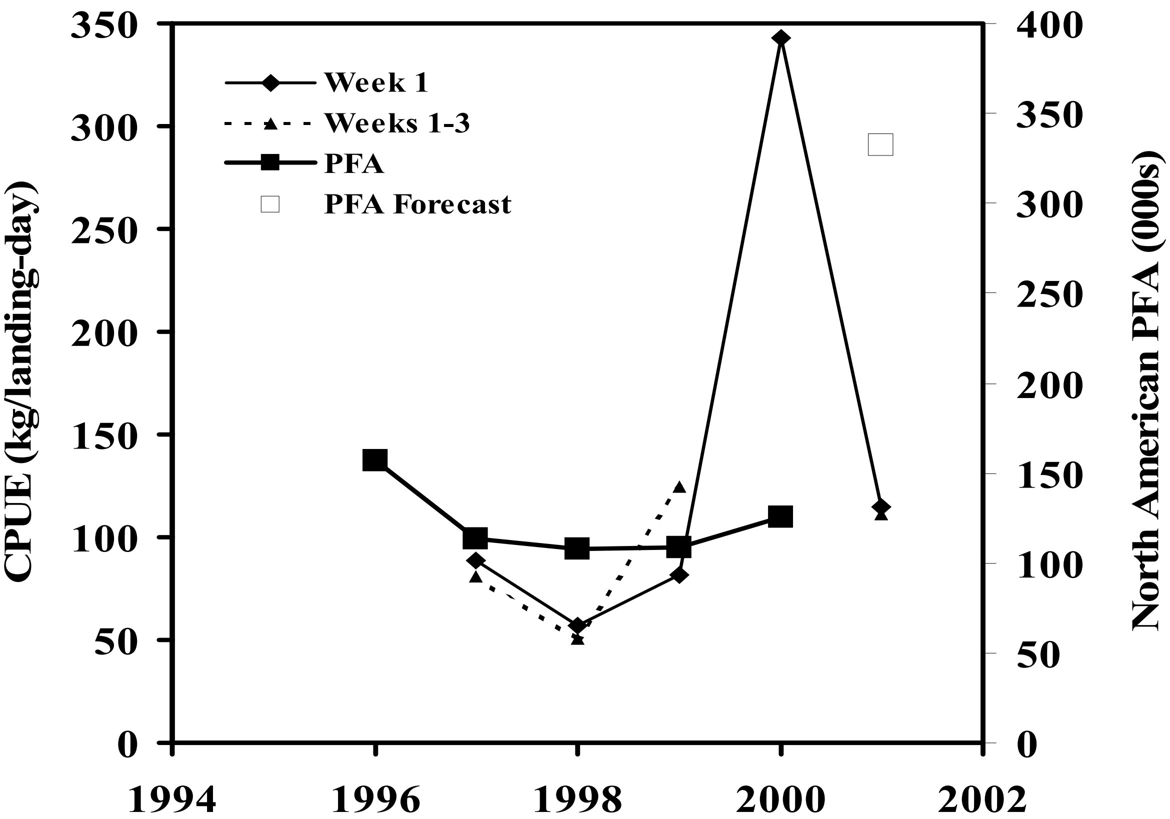


Figure 7.1.2.6. Distribution of landings (kg) of Atlantic salmon from individual commercial trips in the West Greenland fishery from 1997 to 2001.



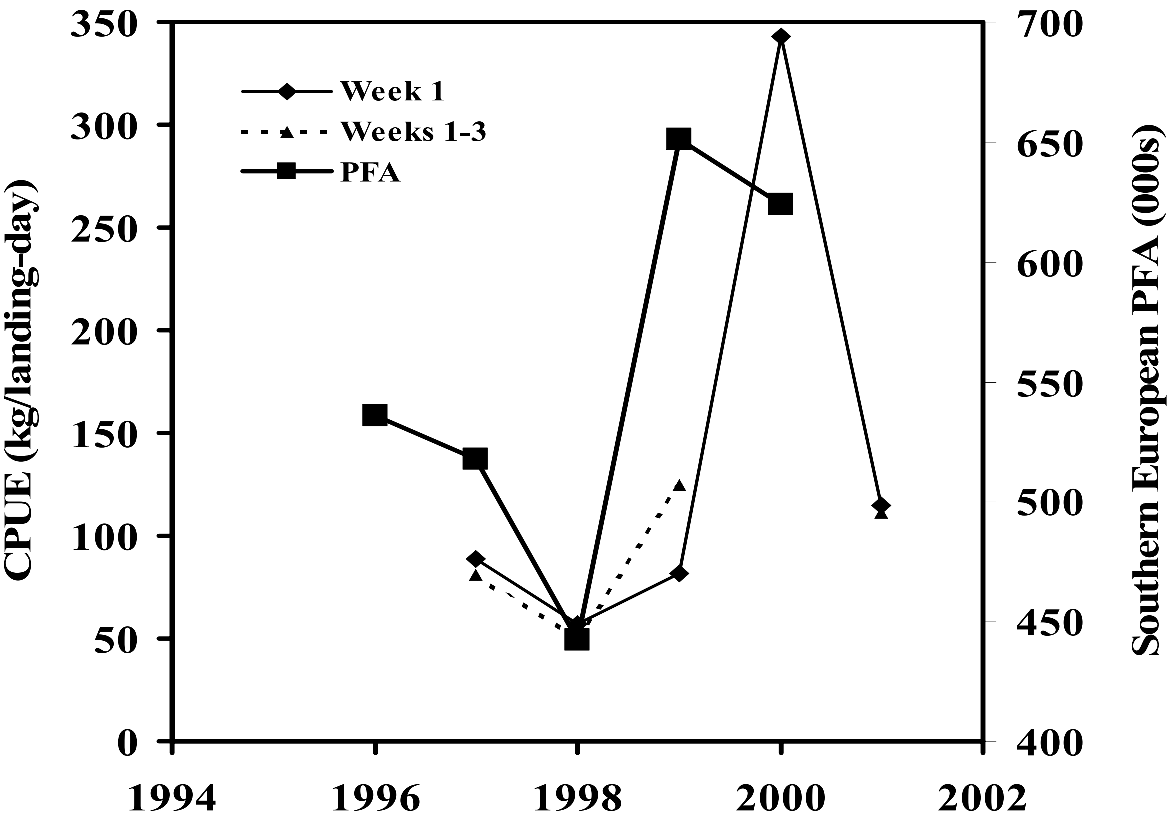


Figure 7.1.2.7 Relationship of CPUE indices used in decision points in the 2001 ad hoc management system and prefishery abundance estimates for the non-maturing 1SW component of the North American (top panel) and Southern European (bottom panel) salmon stock complexes.

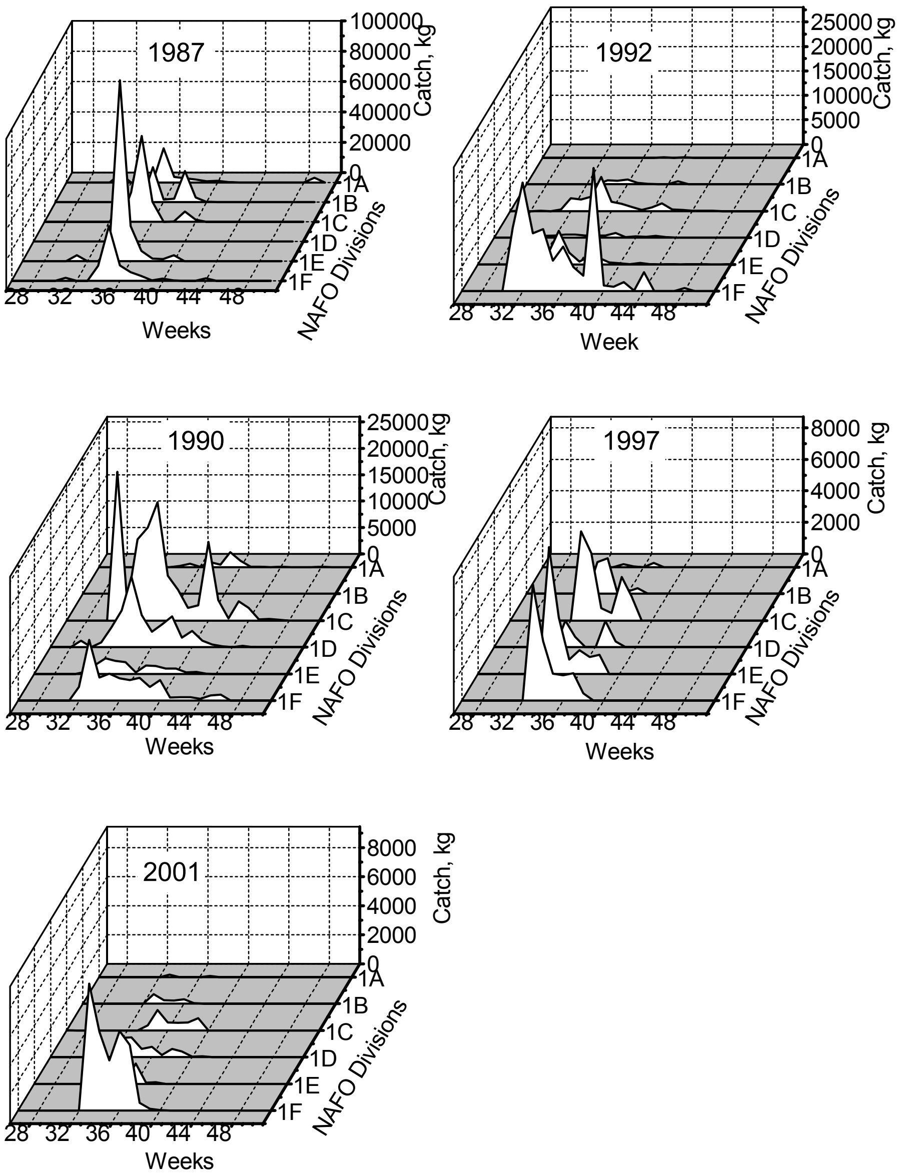


Figure 7.1.4.1 The distribution of landings at Greenland for NAFO Divisions, weeks for the years 1987, 1990, 1992, 1997, and 2001.

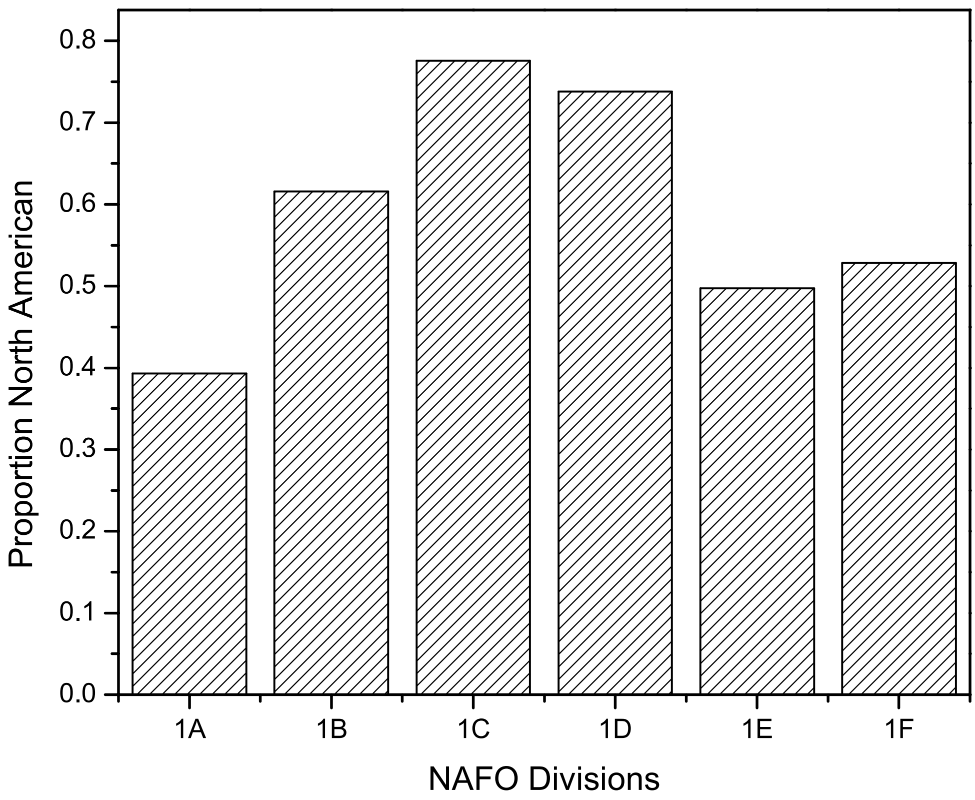


Figure 7.1.4.2 The proportion of North American salmon for NAFO Divisions.

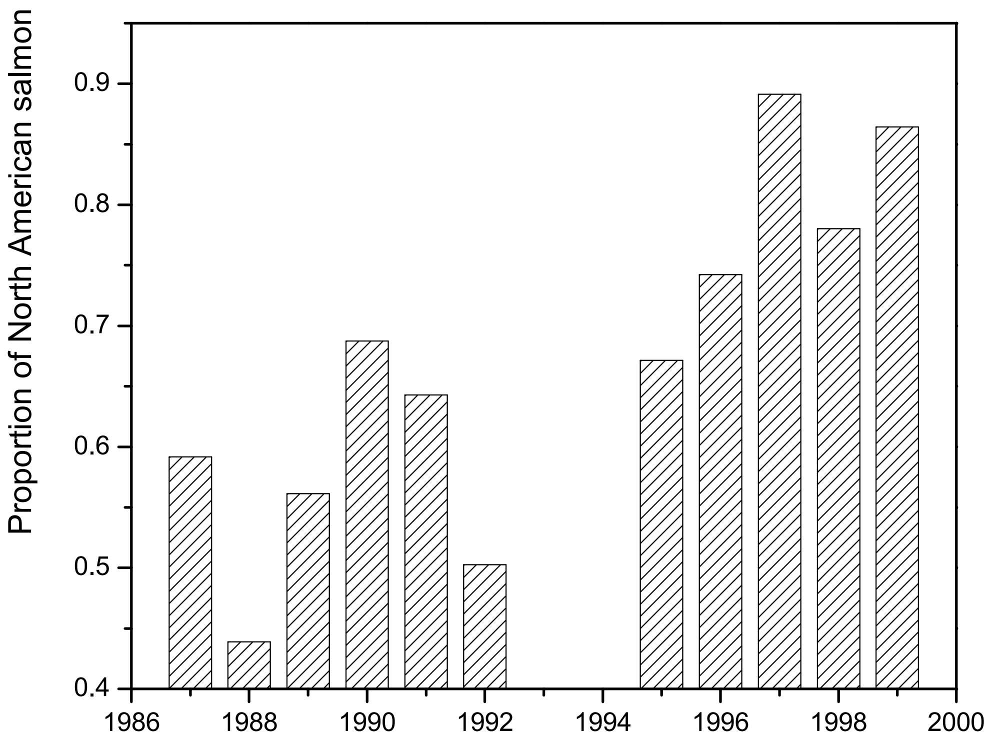


Figure 7.1.4.3 The proportion of North American salmon for years, 1987–1999.

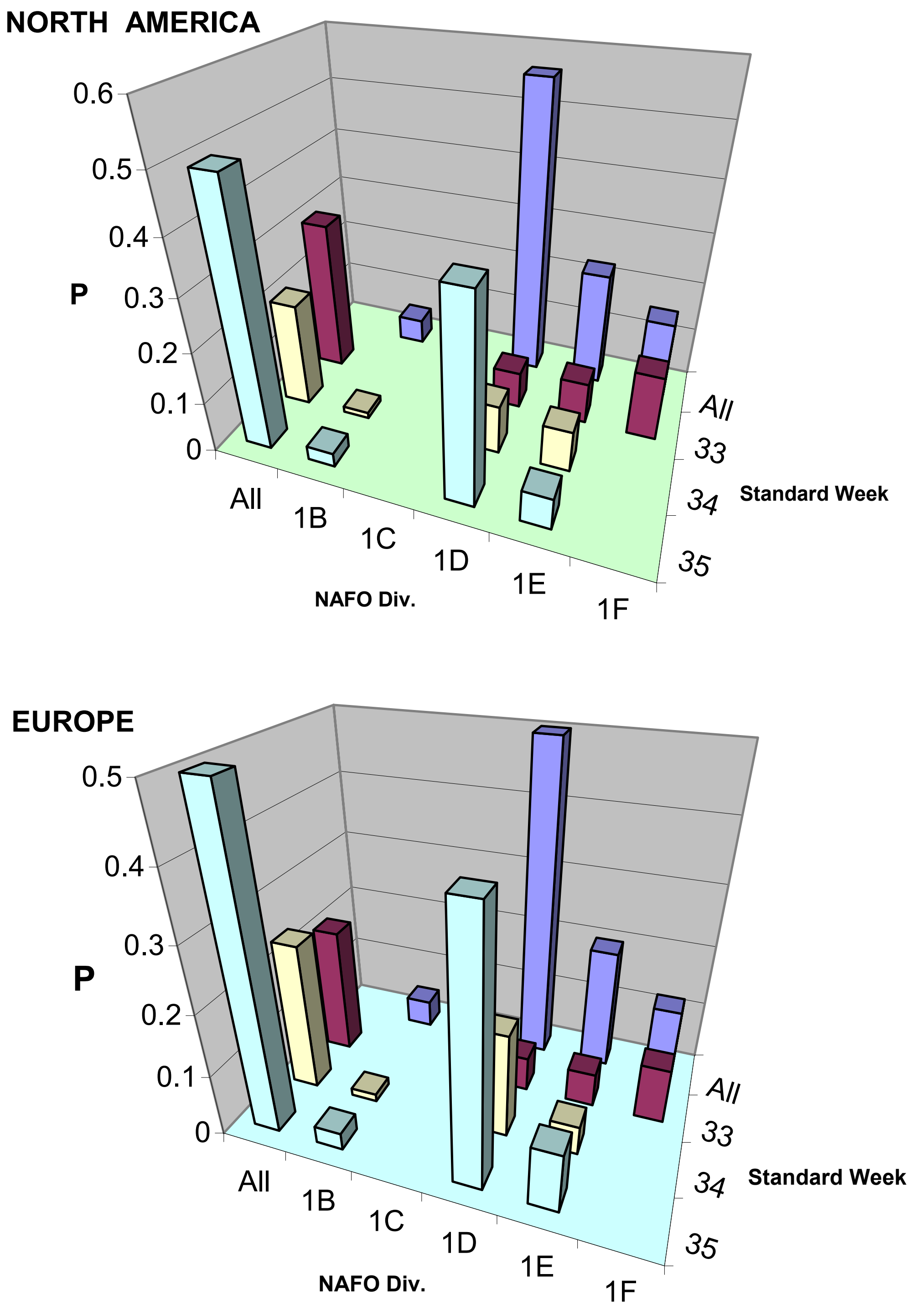


Figure 7.1.4.4 Probability of capture among standard weeks 33 through 35 and NAFO divisions 1B, 1C, 1D, 1E, 1F for fish originating from Europe and North America. Within each graph, the probabilities for rows closest to the walls (All) and within the 3 (week) x 5 (division) space each equal 1. No proportions are presented for under sampled cells. The two ALL rows collapse probabilities over standard week and NAFO division.

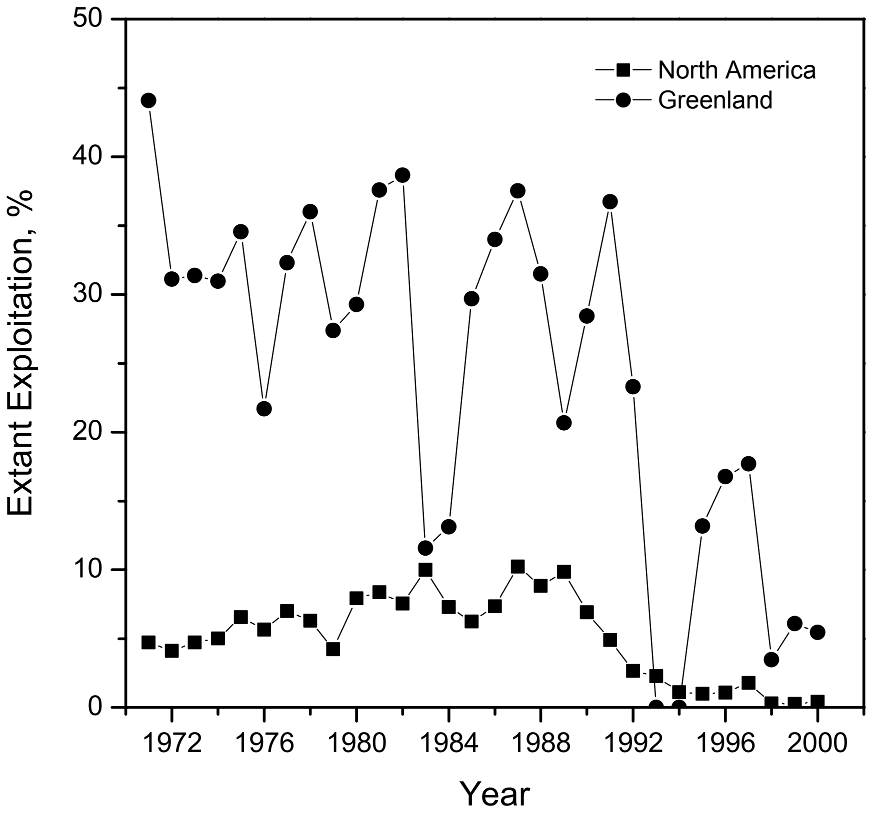


Figure 7.2.1 Extant exploitation of the non-maturing component of North American salmon as 1SW salmon in North America and Greenland from the run-reconstruction statistics.

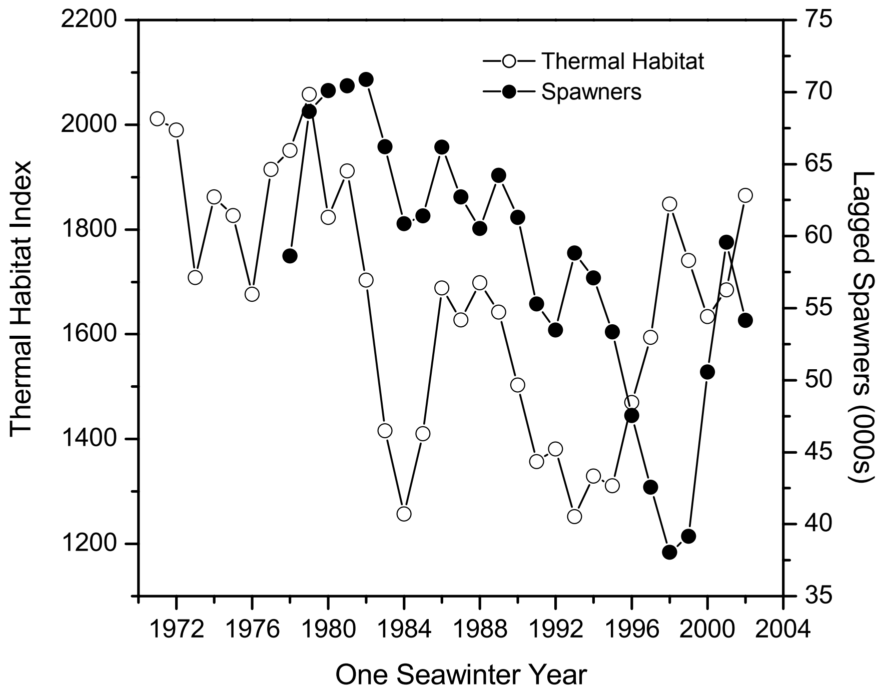


Figure 7.4.1.1 Thermal habitat index for February (H2) and lagged spawners (SLNQ).

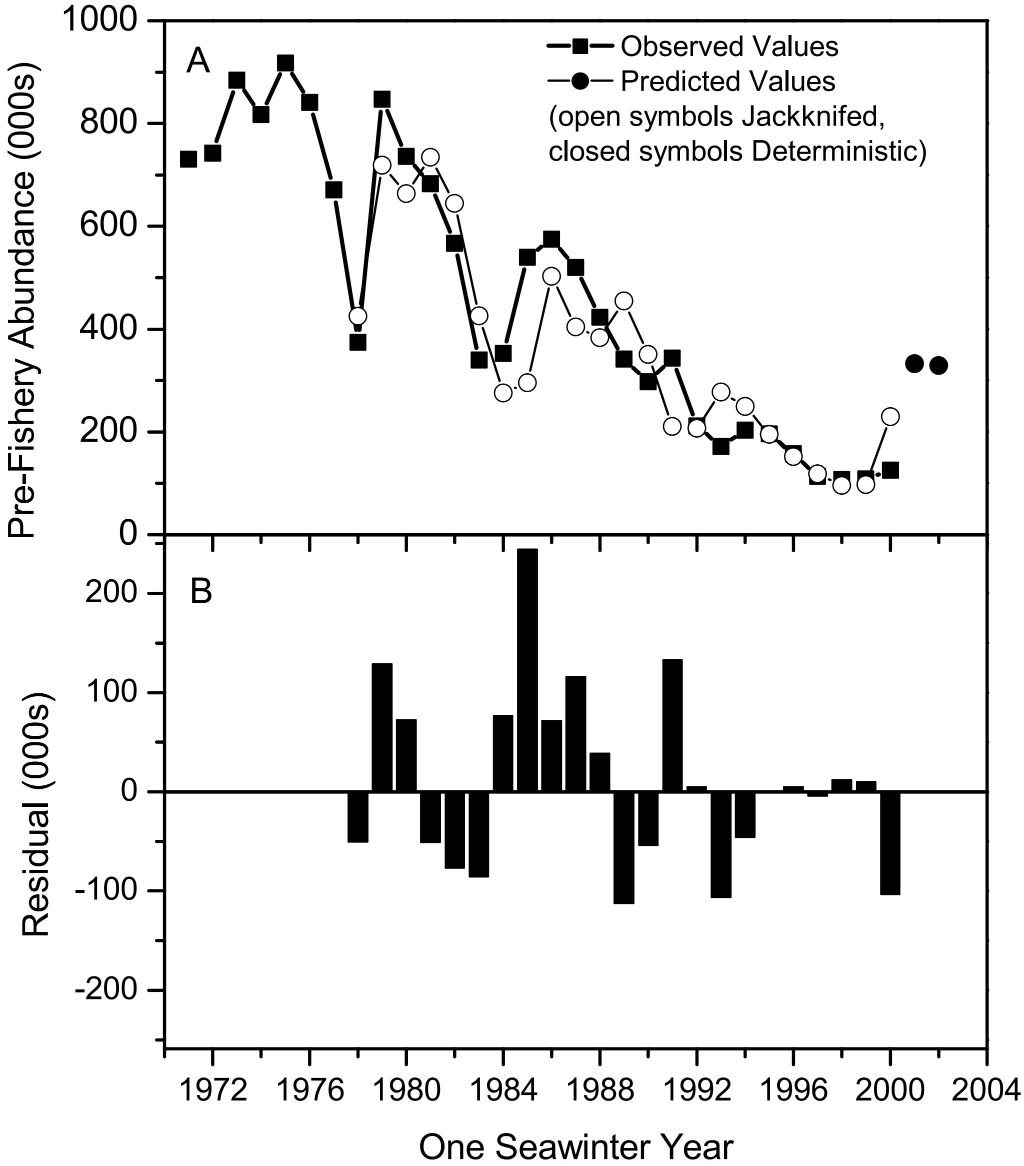


Figure 7.4.1.2 Observed estimates, jackknifed historical predictions, and deterministic forecasts (upper Panel A) of prefishery abundance from the multiplicative model. The residual pattern from the jackknifed predictions is shown in the lower panel (Panel B).

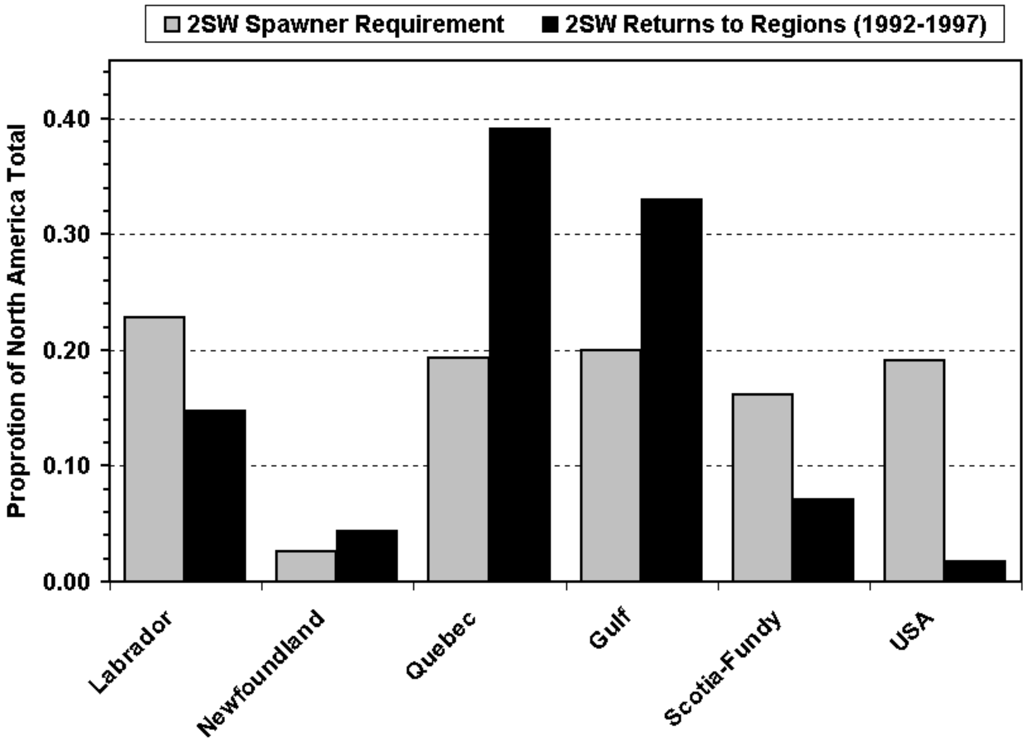


Figure 7.4.3.1 Average returns of 2SW salmon to six regions of North America, expressed as the proportion of total returns to North America, during 1992 to 1997 compared to the 2SW requirements of each region as a proportion of the conservation requirement for North America.

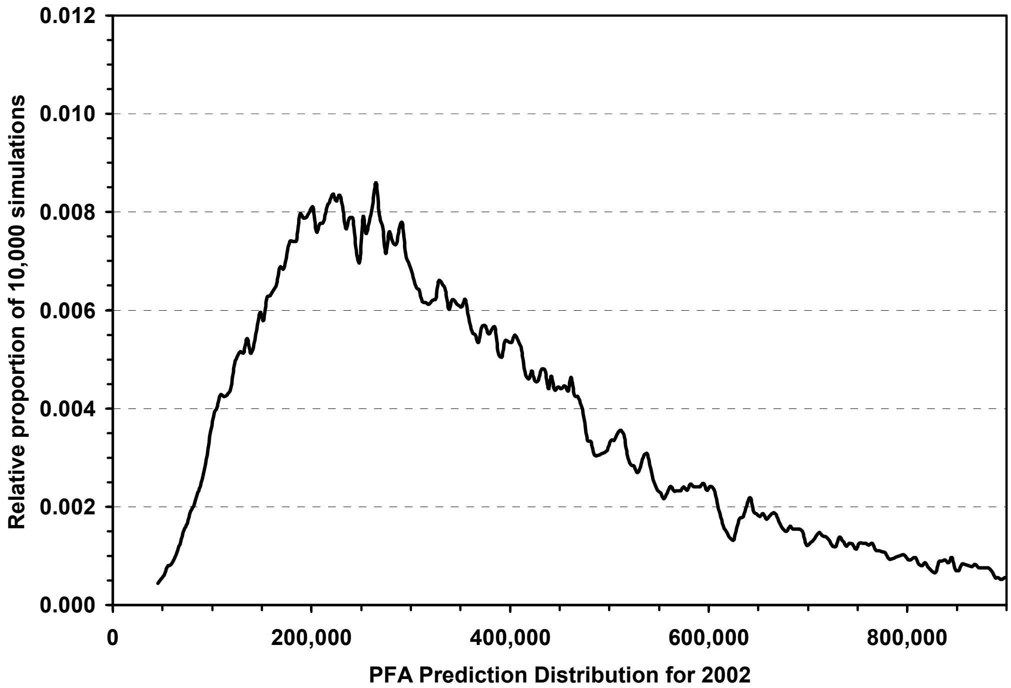


Figure 7.4.3.2 Exact posterior predicted probability distributions of the PFA in year 2002 based on the multiplicative model with errors in the PFA and SNLQ variables. The distributions were generated from 10,000 Monte Carlo simulations.

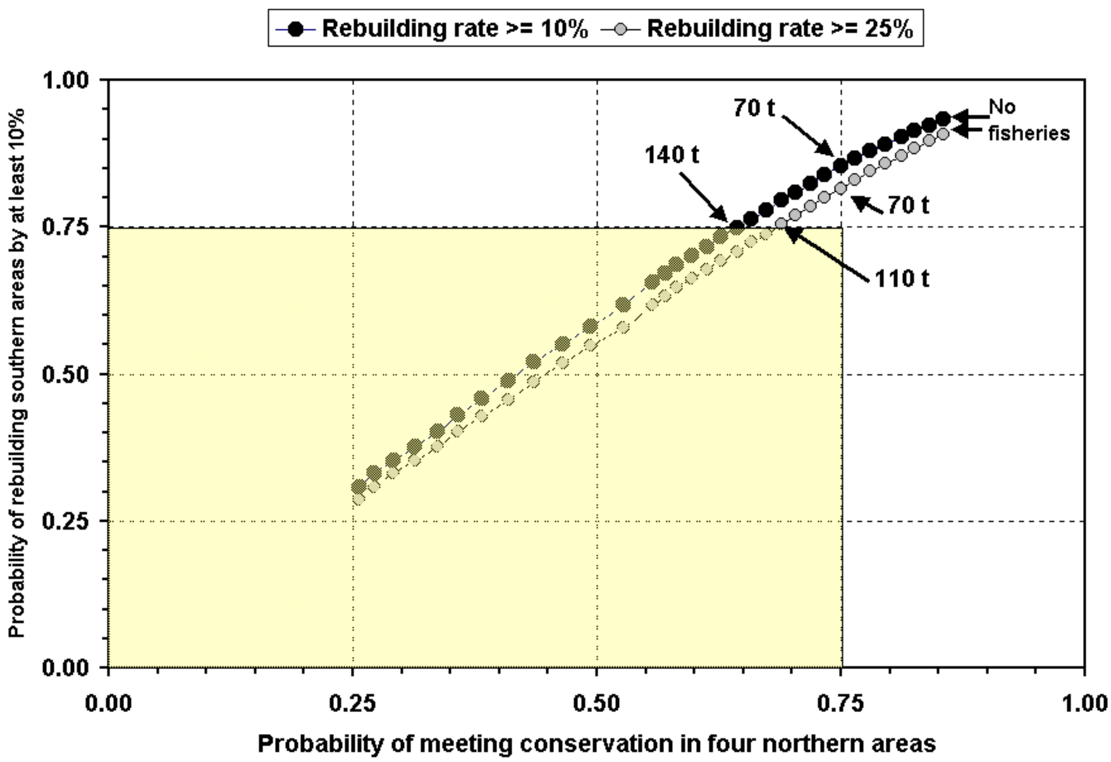


Figure 7.4.3.3 Probability profiles for the management objectives of achieving the 2SW conservation limits simultaneously in the four northern areas of North America (Labrador, Newfoundland, Quebec, Gulf – horizontal axis) and achieving the stock rebuilding objectives for the southern regions of Scotia-Fundy and USA (vertical axis) relative to quota options for West Greenland assuming a 40:60 allocation of the harvest. The symbols represent individual quota (t) options for the West Greenland fishery.

APPENDIX 1

CNL(01)66
REQUEST FOR SCIENTIFIC ADVICE FROM NASCO TO ICES (JULY 2001)

1 with respect to Atlantic salmon in the North Atlantic area:

1.1 provide an overview of salmon catches and landings, including unreported catches by country and catch and release, and worldwide production of farmed and ranched salmon in 2001,
1.2 report on significant developments which might assist NASCO with the management of salmon stocks,
1.3 provide a compilation of tag releases by country in 2001

2 with respect to Atlantic salmon in the North-East Atlantic Commission area:

2.1 describe the key events of the 2001 fisheries and the status of the stocks,
2.2 update the evaluation of the effects on stocks and fisheries of significant management measures introduced since 1991,
2.2 further develop the age-specific stock conservation limits where possible based upon individual river stocks,
2.3 provide catch options or alternative management advice with an assessment of risks relative to the objective of exceeding stock conservation limits,
2.4 Provide an estimate of by-catch of salmon post-smolts in pelagic fisheries based on the scientific information currently available.
2.5 identify relevant data deficiencies, monitoring needs and research requirements;

3 with respect to Atlantic salmon in the North American Commission area

3.1 describe the key events of the 2001 fisheries and the status of the stocks,
3.2 update the evaluation of the effects on US and Canadian stocks and fisheries of management measures implemented after 1991 in the Canadian commercial salmon fisheries
3.3 update age-specific stock conservation limits based on new information as available,
3.4 characterise the reliability of input data used to estimate the lagged spawner variable, with special emphasis on the Labrador region, and evaluate sensitivity of resulting pre-fishery abundance estimates.
3.5 provide catch options or alternative management advice with an assessment of risks relative to the objective of exceeding stock conservation limits,
3.5 identify relevant data deficiencies, monitoring needs and research requirements;

4 with respect to Atlantic salmon in the West Greenland Commission area:

4.1 describe the events of the 2001 fisheries and the status of the stocks,
4.2 update the evaluation of the effects on European and North American stocks of the Greenlandic quota management measures and compensation arrangements since 1993,
4.3 characterise the historical and current temporal and spatial distribution and relative abundance of North American and European Atlantic salmon and, where possible, smaller stock groups, in fisheries at West Greenland.
4.4 provide catch options or alternative management advice with an assessment of risks relative to the objective of exceeding stock conservation limits,
4.5 provide a detailed explanation and critical examination of any changes to the model used to provide catch advice and of the impacts of any changes to the model on the calculated quota
4.6 evaluate the ad hoc management programme and advise on an appropriate management system for the fishery in future years, taking account of the stocks of both North American and European origin
4.7 identify relevant data deficiencies, monitoring needs and research requirements.

NOTES:

1 In response to questions 2.1, 3.1 and 4.1 ICES is asked to provide details of catch, gear, effort, composition and origin of the catch and rates of exploitation. For homewater fisheries the information provided should indicate the location of the catch in the following categories: in-river, estuarine and coastal. Any new information on non-catch fishing mortality of the salmon gear used and on by-catch of other species in salmon gear and of salmon in any new fisheries for other species is also requested.

2 *In response to question 2.4 advise on the potential biases in the catch advice resulting from the inclusion of farm fish escapes in the assessment models.*

3 *In response to question 4.1, ICES is requested to provide a brief summary of the status of the North American and North-East Atlantic salmon stocks. The detailed information on the status of these stocks should be provided in response to questions 2.1 and 3.1.*

4 *With regard to question 4.3 "change to the model " would include the development of any new model.*

APPENDIX 2

Computation of Catch Advice for West Greenland

The North American Spawning Reserve (SpT) for 2SW salmon of 152 548 fish remains the same as in 2000.

This number must be divided by the survival rate for the fish from the time of the West Greenland fishery to their return of the fish to home waters (11 months) to give the Spawning Target Reserve (SpR). Thus:

Eq. 1. SpR = SpT * (exp(11*M) (where M = 0.03)

The Maximum Allowable Harvest (MAH) may be defined as the number of non-maturing 1SW fish that are available for harvest. This number is calculated by subtracting the Spawning Target Reserve from the pre-fishery abundance (PFA).

Eq. 2. MAH = PFA - SpR

To provide catch advice for West Greenland it is then necessary to decide on the proportion of the MAH to be allocated to Greenland (f_{NA}). The allowable harvest of North American non-maturing 1SW salmon at West Greenland NA1SW) may then be defined as

Eq. 3. NA1SW = f_{NA} * MAH

The estimated number of European salmon that will be caught at West Greenland (E1SW) will depend upon the harvest of North American fish and the proportion of the fish in the West Greenland fishery that originate from North America [PropNA] [1]. Thus:

Eq. 4. E1SW = (NA1SW / PropNA) - NA1SW

To convert the numbers of North American and European 1SW salmon into total catch at West Greenland in metric t, it is necessary to incorporate the mean weights (kg) of salmon for North America [WT1SWNA][1] and Europe [WT1SWE][1] and age correction factor for multi-sea winter salmon at Greenland based on the total weight of salmon caught divided by the weight of 1SW salmon [ACF][1]. The quota (in t) at Greenland is then estimated as

Eq. 5. Quota = (NA1SW * WT1SWNA + E1SW * WT1SWE) * ACF/1000

1 Sampling data from the 1995–1999 fishery at West Greenland were used to update the forecast values by exponential smoothing of the proportion of North American salmon in the catch (PropNA), weights by continent [WT1SWNA, WT1SWE] and the age correction factor [ACF].

APPENDIX 3

Chaput, G., F. Caron, L. Marshall. 2002. Estimates of survival of Atlantic salmon in the first and second years at sea. DFO CSAS Res. Doc. 2002/## (in prep.).

Doubleday, W.G., D.R. Rivard, J.A. Ritter, and K.U. Vickers. 1979. Natural mortality rate estimates for North Atlantic salmon in the sea. ICES CM 1979/M:26.

Furnell, D.J. and J.R. Brett. 1986. Model of monthly marine growth and natural mortality for Babine Lake sockeye salmon (Oncorhynchus nerka). Can. J. Fish. Aquat. Sci. 43: 999–1004.

ICES 2000/ACFM:13. Report of the Working Group on North Atlantic Salmon. Copenhagen, 3–14 April 2000. ICES CM 2000/ACFM:13, 301 pp.

ICES 2000. Report of the Working Group on North Atlantic Salmon. *ICES CM 2000/ACFM:13.. ICES Headquarters, Copenhagen, April 3 –13. 301 pp.*

ICES 2001. Report of the ICES Advisory Committee on fisheries management, 2001. ICES Cooperative Research Report 246, 895pp.

ICES 2001/ACFM:15. Report of the Working Group on North Atlantic Salmon. Aberdeen, 2–11 April 2001. ICES CM 2001/ACFM:15, 290 pp.

ICES 2002. Report of the Planning Group on Aerial and Acoustic Surveys for Mackerel. ICES CM 2002/G:03.

McGurk, M.D. 1986. Natural mortality of pelagic fish eggs and larvae: role of spatial patchiness. Mar. Ecol. Prog. Ser. 34: 227–242.

McGurk, M.D. 1996. Allometry of marine mortality of Pacific salmon. Fish. Bull. 94: 77–88.

Rago, P.J., D.G. Reddin, T.R. Porter, D.J. Meerburg, K.D. Friedland and E.C.E. Potter, **1993**. Estimation and analysis of pre-fishery abundance of the two-sea winter populations of North American Atlantic salmon (*Salmo salar* L.), 1974–91. ICES CM **1993/M:25**.

Rago, P.J., D.G. Reddin, T.R. Porter, D.J. Meerburg, K.D. Friedland and E.C.E. Potter. **1993a**. A continental run reconstruction model for the non-maturing component of North American Atlantic salmon: analysis of fisheries in Greenland and Newfoundland-Labrador, 1974–1991. ICES CM **1993/M:25**.

Rago, P.J., D.J. Meerburg, D.G. Reddin, G. J. Chaput, T.L. Marshall, B. Dempson, F. Caron, T.R. Porter, K.D. Friedland, and E.T. Baum. **1993b**. Estimation and analysis of pre-fishery abundance of the two-sea-winter population of North American Atlantic salmon (*Salmo salar*), 1974–1991. ICES CM 1993/M:24.

Ricker, W.E. 1975. Computation and Interpretation of Biological Statistics of Fish Populations. Bull. Fish. Res. Board Canada 191.

Ricker, W.E. 1976. Review of the rate of growth and mortality of Pacific salmon in salt water, and noncatch mortality caused by fishing. J. Fish. Res. Board of Can. 33: 1483–1524.

Shelton, R.G.J., Turrell, W.R., Macdonald, A., McLaren, I.S., and Nicoll, N.T. 1997: Records of post-smolt Atlantic salmon, *Salmo salar* L., in the Faroe-Shetland Channel in June 1996. Fisheries Research 31: 159–162.

8 European eel

ICES (1998, 1999, 2001) has provided advice that the eel stock is outside safe biological limits and current fisheries not sustainable. It is recommended to develop an international recovery plan for the whole stock, and to reduce exploitation to the lowest possible level until such a plan is agreed upon and implemented. ICES also proposed several management measures that could contribute to the recovery plan and reductions in exploitation.

State of the stock and exploitation: The eel stock is outside safe biological limits and the current fishery is not sustainable. Recruitment has been in decline since 1980, which is more than a generation time ago and reached a historical minimum in 2001. The most recent information indicates no improvement in 2002. Eels are exploited in all life stages present in continental waters. Fishing mortality is high both on juvenile (glass eel) and older eel (yellow and silver eel) in many water systems. Total yield has declined to about half that of the mid-1960s. Other anthropogenic factors (habitat loss, contamination, and transfer of diseases) have had negative effects on the stock, possibly of a magnitude comparable to exploitation. All information indicates that the stock is at a historical minimum and continues to decline.

Management objective: There is no stock-wide objective stated for this stock. Some countries are formulating national policies that include both biological and economic considerations, but in most countries no management objective has been set. Management objectives need to be internationally co-ordinated, targeting the whole continental distribution area.

Advice on management: **Actions that would lead to a recovery of the stock are urgently required. Management of eel fisheries requires coordinated action at the scale of catchment areas and higher, commonly spanning multiple jurisdictions. Uncoordinated management actions in isolated areas are not likely to lead to a recovery of the stock. Because of the length of the life cycle, it will take 5–20 years before positive effects can be expected.**

ICES recommends that an international recovery plan be developed for the whole stock on an urgent basis and that exploitation and other anthropogenic mortalities be reduced to as close to zero as possible, until such a plan is agreed upon and implemented.

A range of management measures is documented by ICES in its advice from 2001 and in the report of the ICES/EIFAC Working Group on Eel.

Relevant factors to be considered in management: A recovery plan should include measures to reduce exploitation of all life stages and restore habitats. A long-term rebuilding goal could be to achieve recruitment levels similar to those of the 1980s. Short-term goals on catchment area level could be based on indicators of escapement of glass eel in areas with a glass eel fishery, density and size structure in a yellow eel population, and escapement of silver eels.

Elaboration and special comments: The ecology of eels makes it difficult to demonstrate a stock-recruitment relationship, however, the precautionary approach requires that such a relationship should be assumed to exist for the eel until demonstrated otherwise.

Current scientific knowledge is inadequate to provide management reference points for eel. Considering the many uncertainties in eel management and biology and the uniqueness of the eel stock (one single stock, spawning only once in their lifetime), a precautionary reference point for eel must be stricter than universal provisional reference targets. Exploitation, which provides 30% of the virgin (F=0) spawning stock biomass is generally considered to be such a reasonable provisional reference target. However, for eel a preliminary value could be 50%.

Current monitoring is based on national programmes only. Several of the long-lasting time-series have come under pressure, because of the decreased turnover of the local eel fisheries and the impossibility of addressing the stock decline at the local level. However, in light of the poor state of the stock and the high anthropogenic impacts, it is of utmost importance that existing time-series of monitoring recruitment, effort, and yield should be continued and preferably be supplemented.

Source of information: Report of the ICES/EIFAC Working Group on Eels, 2–6 September 2002 (ICES CM 2003/ACFM:06).

Table 8.1 Recruitment data series. In this table, recruitment data series are listed, in the units in which they were reported. Part 1: Scandinavia and British Isles.

	N	S	S	S	S	DK	D	N.Irl.	Irl	Irl	UK
	Imsa	Göta Älv	Viskan	Motala	Dalälven	Vidaa	Ems	Bann	Erne	Shannon	Severn
1950		2947		305			875				
1951		1744		2713	210		719				
1952		3662		1544	324		1516				
1953		5071		2698	242		3275				
1954		1031		1030	509		5369				
1955		2732		1871	550		4795		167.00		
1956		1622		429	215		4194				
1957		1915		826	162		1829				
1958		1675		172	337		2263				
1959		1745		1837	613		4654		244.00		
1960		1605		799	289		6215	7409	1229		
1961		269		706	303		2995	4939	625		
1962		873		870	289		4430	6740	2469		
1963		1469		581	445		5746	9077	426		
1964		622		181.6	158		5054	3137	208		
1965		746		500	276		1363	3801	932		
1966		1232		1423	158		1840	6183	1394		
1967		493		283	332		1071	1899	345		
1968		849		184	266		2760	2525	1512		
1969		1595		135	34		1687	422	600		
1970		1046		2	150		683	3992	60		
1971		842	12	1	242	787	1684	4157	540		
1972		810	88	51	88	780	3894	2905			
1973		1179	177	46	160	641	289	2524			
1974		631	13	58.5	50	464	4129	5859	794		
1975	42945	1230	99	224	149	888	1031	4637	392		
1976	48615	798	500	24	44	828	4205	2920	394		
1977	28518	256	850	353	176	91	2172	6443	131	1.02	
1978	12181	873	533	266	34	335	2024	5034	320	1.37	
1979	2457	190	505	112	34	220	2774	2089	488	6.69	40.1
1980	34776	906	72	7	71	220	3195	2486	1352	4.50	32.8
1981	15477	40	513	31	7	226	962	3023	2346	2.15	32.0
1982	45750	882	380	22	1	490	674	3854	4385	3.16	30.4
1983	14500	113	308	12	56	662	92	242	728	0.60	6.2
1984	6640	325	21	48	34	123	352	1534	1121	0.50	29.0
1985	3412	77	200	15.2	70	13	260	557	394	1.09	18.6
1986	5145	143	151	26	28	123	89	1848	684	0.95	15.5
1987	3434	168	146	201	74	341	8	1683	2322	1.61	17.7
1988	17500	475	92	170	69	141	67	2647	3033	0.15	23.1
1989	10000	598	32	35.2		9	13	1568	1718	0.03	13.5
1990	32500	149	42	21		5	99	2293	2152	0.47	16.0
1991	6250	264	1	2			52	677	482	0.09	7.8
1992	4450	404	70	108	10		6	978	1371	0.03	17.7
1993	8625	64	43	89	7		20	1525	1785	0.02	20.9
1994	525	377	76	650	72		52	1249	4400	0.29	22.3
1995	1950		6	32	8		40	1403	2400	0.40	36.0
1996	1000	277	1	14	18		20	2667	1000	0.33	25.7
1997	5500	180	8	8	8		5	2533	1038	2.12	16.9
1998	1750		5	6	15		4	1283	782	0.28	20.0
1999	3750		2	85	16		3	1345	1100	0.02	18.0
2000	1625		14	270	12		4	563	900	0.04	7.6
2001	1875		2	178	8		1	250	699	0.003	5.4
2002		685	13					1000	112	0.16	

Table 8.2 Recruitment data series; continued. Part 2: Mainland Europe.

	NL	B	F	F	F	F	F	E	P/E	It
Year	DenOever	Ijzer	Vilaine	Loire	Gironde (CPUE)	Gironde (Yield)	Adour	Nalon	Minho	Tiber
1950	6.56			86						
1951	12.94			166						
1952	83.88			121				14529		
1953	12.22			91				8318		
1954	18.32			86				13576		
1955	25.15			181				16649		
1956	6.68			187				14351		
1957	14.98			168				12911		
1958	47.75			230				13071		
1959	26.73			174				17975		
1960	20.67			411				13060		
1961	35.7			334				17177		
1962	80.48			185				11507		
1963	115.38			116				16139		
1964	36.42	3.7		142				20364		
1965	75.26	115.0	5.0	134				11974		
1966	17.9	385.0	4.0	253				12977		
1967	28	575.0	9.0	258				20556		
1968	19.06	553.5	12.0	712				15628		
1969	16.16	445.0	10.0	225				18753		
1970	36.49	795.0	8.0	453				17032		
1971	16.52	399.0	44.0	330				11219		
1972	28.99	556.5	38.0	311				11056		
1973	22.26	356.0	78.0	292				24481		
1974	24.53	946.0	107.0	557				32611	1.642	
1975	32.14	264.0	44.0	497				55514	10.578	11.00
1976	25.51	618.0	106.0	770				37661	20.048	6.70
1977	56.8	450.0	52.0	677				59918	36.637	5.90
1978	37.47	388.0	106.0	526				37468	24.334	3.60
1979	50.32	675.0	209.0	642	19.7	286.2		42110	28.435	8.40
1980	25.79	358.0	95.0	525.5	25.9	404.8		34645	21.32	8.20
1981	21.59	74.0	57.0	302.7	20.0	332.2		26295	54.208	4.00
1982	13.71	138.0	98.0	274	15.0	123.3		21837	16.437	4.00
1983	8.98	10.0	69.0	259.5	13.6	80.3		22541	30.447	4.00
1984	12.3	6.0	36.0	182.5	19.2	82.0		12839	31.387	1.80
1985	13.79	13.0	41.0	154	9.6	64.5		13544	20.746	2.50
1986	14.42	26.0	52.6	123.4	10.6	45.2	8	23536	12.553	0.20
1987	5.71	33.0	41.2	145	14.0	82.4	9.5	15211	8.219	7.40
1988	3.88	48.0	46.6	176.6	10.9	33.0	12	13574	8.001	10.50
1989	2.71	30.0	36.7	87.1	7.2	80.0	9	9216	9.000	5.50
1990	3.29	218.2	35.9	96	5.6	48.1	3.2	7117	6.000	4.40
1991	0.99	13.0	15.4	35.7	7.7	64.0	1.5	10259	9.000	0.80
1992	2.6	18.9	29.6	39.3	3.7	41.7	8	9673	10.000	0.60
1993	2.61	11.8	31.0	90.5	8.2	69.4	5.5	9898	7.600	0.50
1994	4.48	17.5	24.0	94.6	8.7	45.8	3	12602	4.700	0.50
1995	6.52	1.5	29.7	132.5	8.2	73.2	7.5	5992	15.200	0.30
1996	7.38	4.5	22.4	80.8	4.8	30.7	4.1	3655	8.700	0.10
1997	11.9	9.8	22.6	70.8	6.5	50.5	4.6	3275	7.400	0.10
1998	2.12	2.3	17.5	60.7	4.3	25.0	1.5	3814	7.400	0.13
1999	3.27		15.3	86.9	7.5	44.1	4.3	1331		0.06
2000	1.62	17.9	14.2	79.9			10	1289		0.07
2001	0.53	1.0	8.1							0.04
2002	1.09	1.4	16.0							0.02

Table 8.3 Statistics of eel landings, reported in the FAO database of fishing yields. These data include landings of 'river eels' in Atlantic waters, the Mediterranean, and Inland waters. Data for Denmark, Netherlands, and Italy have been corrected for incorrectly included aquaculture yield.

Country year	Norway	Sweden	Denmark	Germany	Ireland	UK	Netherlands	France	Spain	Portugal	Italy	Remaining Europe	Northern Africa
1950	300	2188	4500	400			4200	500	100		1000		
1951	300	1929	4400	400			3700	500	100		1000		
1952	200	1598	3900	400			4000	700	100		1000		
1953	400	2378	4300	500		400	3100	600	100		1000	900	
1954	300	2106	3800	300		500	2100	500	900		1000	800	
1955	500	2651	4800	500		700	1700	500	600		1000	1000	
1956	300	1533	3700	400		600	1800	500	800		2000	900	
1957	400	2225	3600	400		600	2500	500	500		2000	800	
1958	400	1751	3300	400	100	600	2700	500	500		2100	1200	
1959	400	2789	4000	500	100	500	3400	900	500		3000	700	
1960	400	1646	4723	400	0	800	3000	1300	500		2700	1000	
1961	500	2066	3875	500	100	800	2660	1300	400		2600	900	300
1962	400	1908	3907	400	100	700	1543	1300	800		3100	1000	300
1963	500	2071	3928	2100	100	700	1818	1400	1100		3500	1000	300
1964	400	2288	3282	1900	100	600	2368	1400	1700		3500	1100	400
1965	500	1802	3197	1500	200	800	2509	1700	1300		3200	900	500
1966	500	1969	3690	1700	100	1000	2739	1300	1300		3100	1000	400
1967	500	1617	3436	1900	100	600	2884	2000	1400		3100	1100	400
1968	600	1808	4218	1800	100	600	2622	2700	1300		3200	1100	400
1969	500	1675	3624	1600	100	600	2741	1900	1400		3400	1100	400
1970	400	1309	3309	1600	200	800	1512	4200	1100		3300	1400	100
1971	400	1391	3195	1300	100	800	1153	4900	1100		3400	1500	100
1972	400	1204	3229	1300	100	700	1057	2600	1000		2900	1138	100
1973	400	1212	3455	1300	100	800	1023	3900	700		2900	1150	800
1974	383	1034	2814	1285	67	817	994	2493	1300	42	2697	1528	352
1975	411	1399	3225	1398	79	833	1173	1590	570	44	2973	1400	85
1976	386	935	2876	1322	150	694	1306	2959	675	38	2677	1254	47
1977	352	989	2323	1317	108	742	929	1538	666	52	2462	1384	159
1978	347	1076	2335	1162	76	877	862	2455	655	44	2237	1357	112
1979	374	956	1826	1164	110	879	687	3144	394	25	2422	1518	134
1980	387	1112	2141	1051	75	1053	828	4503	300	32	2264	1242	448
1981	369	887	2087	1033	94	858	876	1425	250	33	2340	1192	497
1982	385	1161	2378	1027	144	1032	1097	1469	200	14	2087	1419	455
1983	324	1173	2003	1029	117	1113	1230	1856	150	11	2076	1782	575
1984	309	1073	1745	911	88	957	681	2336	150	80	2361	2445	477
1985	352	1140	1519	866	87	781	666	2288	200	76	1907	2123	258
1986	271	943	1552	887	87	997	729	2924	200	633	1928	1867	356
1987	282	897	1189	731	221	939	512	2378	259	566	2076	2479	306
1988	513	1162	1759	746	215	715	590	2879	205	501	2165	2790	256
1989	312	952	1582	678	400	1075	645	2482	83	6	1301	2365	368
1990	336	942	1568	976	256	1039	657	2484	75	295	1199	2209	560
1991	323	1084	1366	1010	245	822	707	2260	65	314	1106	2337	358
1992	373	1180	1342	1026	234	782	621	1964	60	674	1662	2749	358
1993	340	1210	1023	1027	260	752	320	1674	55	505	1307	2509	613
1994	472	1553	1140	585	300	873	369	1417	50	979	986	2797	732
1995	454	1205	840	585	400	808	279	500	106	10	886	2572	1176
1996	352	1134	717.5	696	550	895	336	563	97	21	883	2676	984
1997	497	1382	757.6	746	550	807	315	1942	113	16	1010	2034	1327
1998	353	645	557	717	670	741	346	491	160	13	682	2159	1069
1999	475	734	686	747	675	697	372	189	166	3		1532	1257
2000	281	561	620	686	250	796	368	247	48	29		604	30
2001		429			110	795	351						

Table 8.4 Re-stocking of glass eel and yellow eel smaller than minimum legal size (bootlace eel). Numbers of eels (in millions) re-stocked in (eastern) Germany (D east), the Netherlands (NL), Sweden (S), Poland (PO), and Northern Ireland (N.Irl.).

	D east	NL	S	PO	N.Irl.	Flanders
1945					17.0	
1946		7.3			21.0	
1947		7.6				
1948		1.9				
1949		10.5				
1950	0.0	5.1				
1951	0.0	10.2	0.0			
1952	0.0	16.9	0.1	17.6		
1953	2.2	21.9	0.0	25.5		
1954	0.0	10.5		26.6		
1955	10.2	16.5		30.8	0.5	
1956	4.8	23.1		21.0		
1957	1.1	19.0		24.7		
1958	5.7	16.9		35.0		
1959	10.7	20.1		52.5	0.7	
1960	13.7	21.1		64.4	25.9	
1961	7.6	21.0		65.1	16.7	
1962	14.1	19.8		61.6	27.6	
1963	20.4	23.2		41.7	28.5	
1964	11.7	20.0	0.0	39.2	10.0	
1965	27.8	22.5		39.8	14.2	
1966	21.9	8.9		69.0	22.7	
1967	22.8	6.9		74.2	6.7	
1968	25.2	17.0			12.1	
1969	19.2	2.7			3.1	
1970	27.5	19.0			12.2	
1971	24.3	17.0			14.1	
1972	31.5	16.1			8.7	
1973	19.1	13.6			7.6	
1974	23.7	24.4			20.0	
1975	18.6	14.4			15.1	
1976	31.5	18			9.9	
1977	38.4	25.8			19.7	
1978	39.0	27.7			16.1	
1979	39.0	30.6	0.1		7.7	
1980	39.7	24.8	0.1		11.5	
1981	26.1	22.3			16.1	
1982	30.6	17.2			24.7	
1983	25.2	14.1			2.9	
1984	31.5	16.6			12.0	
1985	6.0	11.8	0.8		13.8	
1986	23.8	10.5	0.1		25.4	
1987	26.3	7.9	0.0		25.8	
1988	26.6	8.4	0.2		23.4	
1989	14.3	6.8	0.0		9.9	
1990	10.65	6.1	0.7		13.3	
1991	2.01	1.9	0.3		3.5	
1992	6.36	3.5	0.3		9.4	
1993	7.62	3.8	0.6		9.9	0.8
1994	7.6	6.2	1.7		16.4	0.5
1995	0.99	4.8	1.5		13.5	0.5
1996	0.05	1.8	2.3		11.1	0.5
1997	0.38	2.3	2.4		10.9	0.4
1998	0.3	2.5	2.1		6.2	0.0
1999	0.0	2.9	2.2		12.0	0.8
2000	0.0	2.8	1.2		5.4	0.0
2001		0.9	0.7		2.8	0.2
2002		1.6				

Table 8.4 Cont. Re-stocking of glass eel and yellow eel smaller than minimum legal size (bootlace eel). Numbers of eels (in millions) re-stocked in (eastern) Germany (D east), the Netherlands (NL), Sweden (S), Poland (PO), and Northern Ireland (N.Irl.).

	D east	NL	S	DK	Flanders
1945					
1946					
1947		1.6			
1948		2.0			
1949		1.4	0.0		
1950	0.9	1.6	0.0		
1951	0.9	1.3	0.0		
1952	0.6	1.2	0.0		
1953	1.5	0.8	0.0		
1954	1.1	0.7	0.0		
1955	1.2	0.9	0.0		
1956	1.3	0.7	0.0		
1957	1.3	0.8	0.0		
1958	1.9	0.8	0.0		
1959	1.9	0.7	0.0		
1960	0.8	0.4	0.0		
1961	1.8	0.6	0.0		
1962	0.8	0.4	0.0		
1963	0.7	0.1	0.0		
1964	0.8	0.3	0.1		
1965	1.0	0.5	0.1		
1966	1.3	1.1	0.1		
1967	0.9	1.2	0.1		
1968	1.4	1.0	0.1		
1969	1.4	0.0	0.0		
1970	0.7	0.2	0.0		
1971	0.6	0.3	0.0		
1972	1.9	0.4	0.1		
1973	2.7	0.5	0.1		
1974	2.4	0.5	0.1		
1975	2.9	0.5	0.1		
1976	2.4	0.5	0.1		
1977	2.7	0.6	0.0		
1978	3.3	0.8	0.1		
1979	1.5	0.8	0.1		
1980	1.0	1.0	0.1		
1981	2.7	0.7	0.1		
1982	2.3	0.7	0.4		
1983	2.3	0.7	1.0		
1984	1.7	0.7	0.8		
1985	1.1	0.8	0.9		
1986	0.0	0.7	0.5		
1987	0.0	0.4	1.0	1.6	
1988	0.0	0.3	1.3	0.8	
1989	0.0	0.1	1.0	0.4	
1990	0.1	0.0	1.6	3.5	
1991	0.1	0.0	1.8	3.1	
1992	0.1	0.0	2.2	3.9	
1993	0.2	0.2	2.0	4.0	0.2
1994	0.2	0.0	2.0	7.4	0.1
1995	0.7	0.0	1.8	8.4	0.1
1996	0.9	0.2	2.5	4.6	0.1
1997	1.5	0.4	2.5	2.5	0.1
1998	1.2	0.6	2.4	3.0	0.1
1999	1.1	1.2	2.4	4.1	0.1
2000	1.0	1.0	1.5	3.8	0.0
2001			0.4	1.7	0.0
2002	0.4				

Table 8.5 Production of European eel in aquaculture in Europe and Asia. Compilation of production estimates (tonnes) derived from reports of previous meetings, FAO, FEAP, and others.

	1984	1985	1986	1987	1988	1989	1990	1991	1992
Norway									
Sweden	15	47	59	193	233	190	160	195	192
Denmark	18	40	200	240	195	430	586	866	748
Germany									
Ireland									
UK				20	30	0	0		
Netherlands		20	100	200	200	350	550	520	1250
Belgium/Lux.					30	30	125	125	125
Spain	15	20	25	37	32	57	98	105	175
Portugal	60	60	590	566	501	6	270	622	505
Marocco							35	41	68
Algeria					72	53	22	1	0
Tunisia							150	151	250
Italy	2600	2800	4200	4600	4250	4500	3700	4185	3265
Greece			6	4	10	54	94	132	337
Turkey									
Macedonia									1
Yugoslavia	44	52	48	49	19	10	5	1	8
Croatia								7	5
Hungary					90	39	73	33	
Czech.rep.									2
Sum EU	1950	2229	3448	4729	5517	5159	6667	6098	6818
Japan		3000							

	1993	1994	1995	1996	1997	1998	1999	2000	2001
Norway	120	200	200	200	200				
Sweden	182	158	184	215	250	250	250	260	253
Denmark	782	1034	1324	1568	1913	2483	2718	2674	2040
Germany	100	100	100	150	150	150	150	300	160
Ireland								100	
UK		25		25					
Netherlands	1487	1535	2800	2443	3250	3800	4000	3800	3228
Belgium/Lux.	125	150	140	150	150	40	20	50	55
Spain	134	214	249	266	270	300	425	200	
Portugal	979	200	110	200	200	200	200		
Marocco	85	55	55	56					
Algeria	22	20	17	17					
Tunisia	260	108	158	147	108				
Italy	3000	2800	3000	3000	3100	3100	3100	2750	2500
Greece	341	659	550	312	500	500	300	600	
Turkey									
Macedonia	0	70	83	60					
Yugoslavia	2	9	5	5					
Croatia	5	7	6	7					
Hungary	50		50			19	19		
Czech.rep.	4	4	3	3					
Sum EU	7721	7689	8935	9031	10646	11059	10839	10510	8435
Japan								10000	

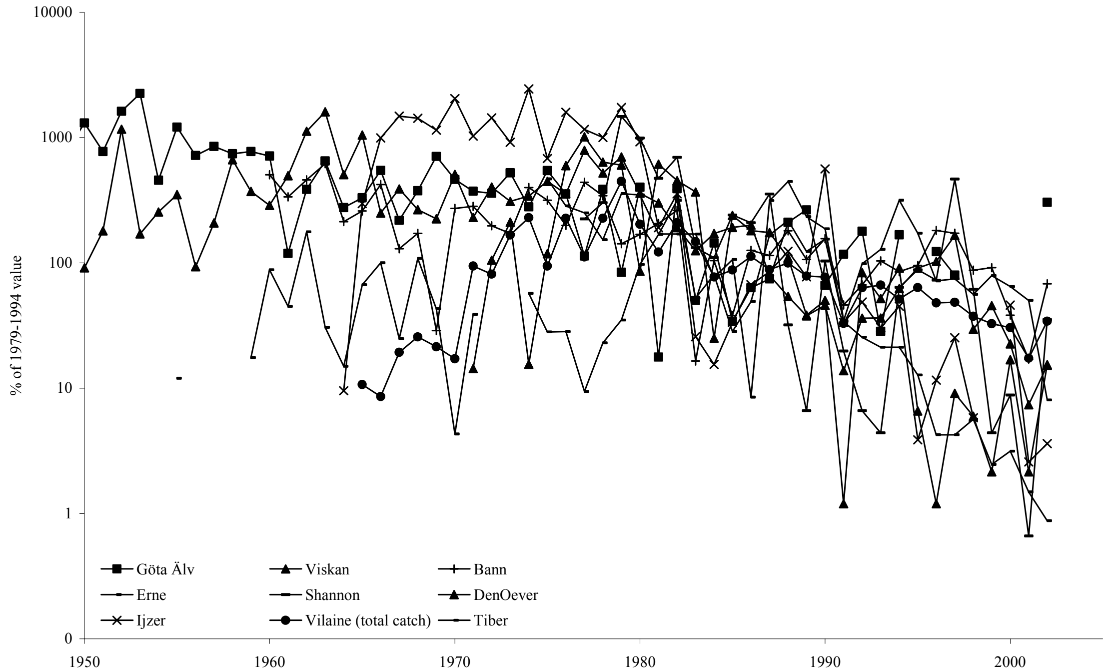


Figure 8.1 Time-series of glass eel monitoring in Europe. Each series has been scaled to the 1979–1994 average. The heavy line indicates the geometric mean of the series from Loire (F), Ems (D), Gota Alv (S), and DenOever (NL), which are the longest and most consistent time-series.

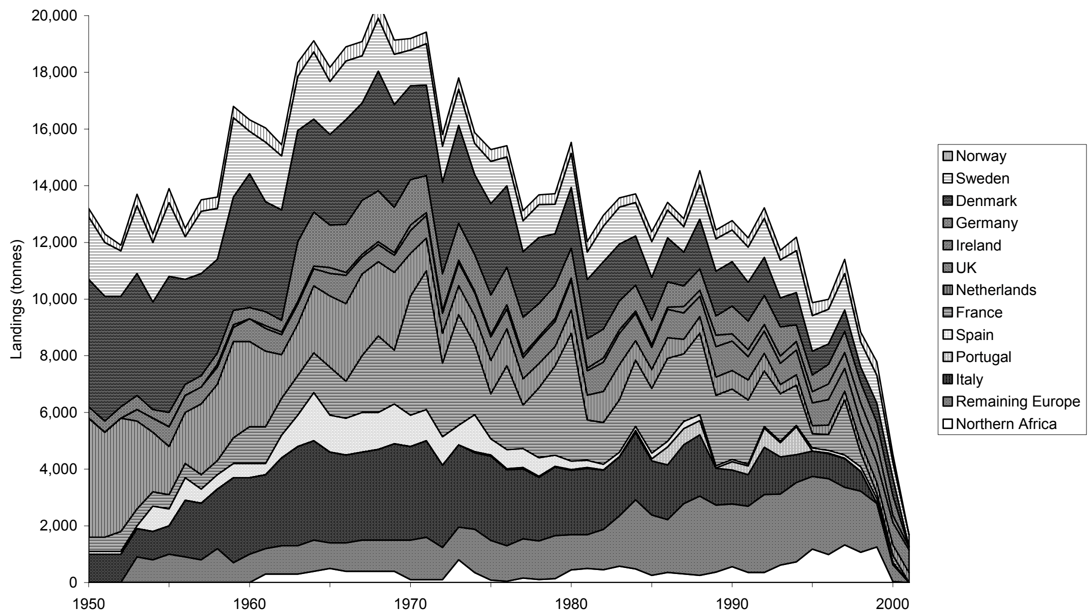


Figure 8.2 Landing statistics of the eel in the past 50 years, as reported by FAO database, with minor corrections.

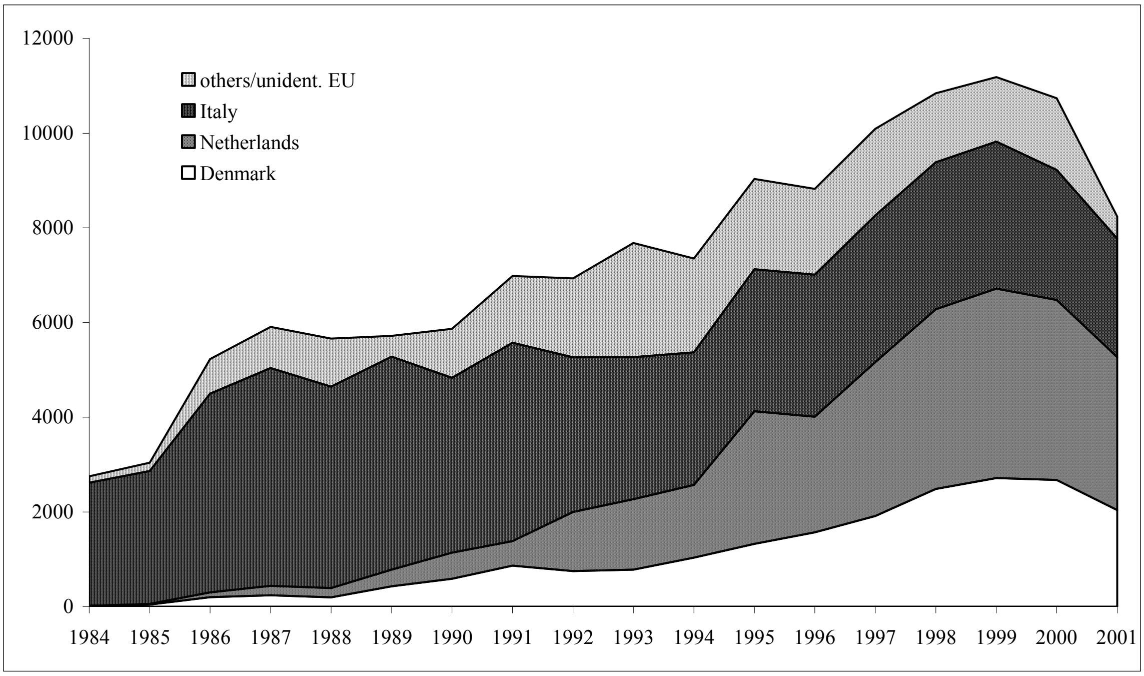


Figure 8.3 Trends in aquaculture production of the European eel.