ICES Diadromous Fish Committee
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Report of the ICES/EIFAC Working Group on Eels (WGEEL)

22–26 November 2004
Galway, Ireland

International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer

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Contents

1 Introduction

At the 91st Statutory Meeting of ICES (2004) and the 24th meeting of EIFAC (2004) it was decided that:

The **ICES/EIFAC Working Group on Eels** [WGEEL] (Chair: W. Dekker, Netherlands) will meet in Galway, Ireland from 22–26 November 2004 to:

a) report on appropriate rebuilding goals for recovery of eel stocks/populations and advise on the factors which would affect their implementation;
b) specify practical monitoring requirements to evaluate progress towards the objectives of a stock recovery plan;
c) specify the scientific and management actions needed for implementation of a stock recovery plan;
d) assess trends in recruitment, stock and fisheries indicative for the status of the stock;
e) continue work to expand the data bases and knowledge on eels in Europe and North America, to provide a more complete basis for recovery of these stocks/populations.

17 people attended the meeting, from seven countries (see Annex 1).

The current Terms of Reference and Report constitute one step in an ongoing process of documenting the status of the European eel stock and fisheries and compiling management advice. As such, the current Report does not present a comprehensive overview, but should be read in conjunction with previous reports (ICES, 2000; 2002a; 2003; 2004).

In the past meetings of the Working Group, attention focused on documenting the poor status of the stock, listing available options for management, and advising on management action. Within ICES, those meetings were organised under the Advisory Committee on Fisheries Management ACFM, with the aim to respond to requests for management advice. The current meeting was organised under ICES Diadromous Fish Committee DFC, to continue and extend several developments which will eventually contribute to a stock recovery plan. The current report focuses predominantly on the structures and tools required for sustainable management of the stock. For EIFAC, this re-direction of the working groups objectives still fits within the scope of the group.

The structure of this report does not strictly follow the order of the Terms of Reference for the meeting, since different aspects of subjects where covered under different headings and a rearrangement of the Sections by subject was considered preferable. Section 2 presents updates of the data series on recruitment, stock and yield. In addition, new information is presented on the seasonality of the eel fisheries, and the spatial and temporal consistency in the seasonality. Section 3 discusses the objectives of sustainable management, and the various complications arising in practical implementation of this objective. Section 4 discusses current and required approaches in modelling eel stock dynamics, in relation to the objectives (Section 3) and to monitoring. Section 5 discusses monitoring of eel stocks and fisheries, and considers the relevance of ongoing, wider-scoped monitoring programmes for the specific purpose of eel stock management. Finally, Section 6 summarises the conclusions, and presents the recommendations. Appendices at the end of the report present elaborations of specific material. In particular, Annex 2 discusses the ongoing review of landings statistics; Annex 3 provides a short presentation of current modelling approaches; and finally Annex 4 contains the individual Country Reports, as submitted to the working group meeting.

The first Term of reference considers rebuilding goals. The conceptual aspects of this discussion are dealt with in Section 3, while the technical details of deriving adequate goals are discussed in Section 4. The second Term of Reference is dealt with in Section 5. Scientific and management actions (ToR c) are detailed in Sections 3, 4 and 5. Section 2 presents the most recent data updates, indicated in ToR d, but also extends our knowledge (ToR e), specifically with regard to the fishing season for the different life stages, throughout Europe.

2 Trends in Recruitment, Stock and Yield

2.1 Trends in recruitment

There are relatively few data sets, which provide information on the recruitment of the European eel, and those there are relate to various stages (pigmentation, behaviour) of the recruitment into continental habitats (Dekker, 2002). Available time-series from 19 river catchments in 12 countries have been examined for trends, with data from 10 rivers available for 2003 (Table 2.1.1). The data analysed were derived from both fishery-dependent sources (i.e. catch records) and fishery-independent surveys across much of the geographic range of the European eel, and cover varying time intervals.

Downward trends are evident over the last two decades of all time-series, reflecting the rapid decrease after the high levels of the 1970s. Through the 1980s, the trend continued downwards, possibly with the exception of the Erne in northwestern Ireland in which no trend was apparent. In the 1990’s most series have shown fairly stable low levels, with a historical minimum recorded in 2001. The levels of recruitment in 2004 appear to be similar to that in previous years and do not show a substantial recovery from the 2001 historical minimum for the whole stock.

In northern areas, no glass eels are found to recruit into the rivers, while the transition to the yellow eel stage happens long before the immigration into fresh water. Figure 2.1.2 presents the results of these data series. In the mid-1990s, a moderate recovery in glass eel recruitment occurred (Figure 2.1.1). The data on yellow eel recruitment recently showed an increasing trend, apparently related to the temporary recovery of the glass eel in the mid-1990s.

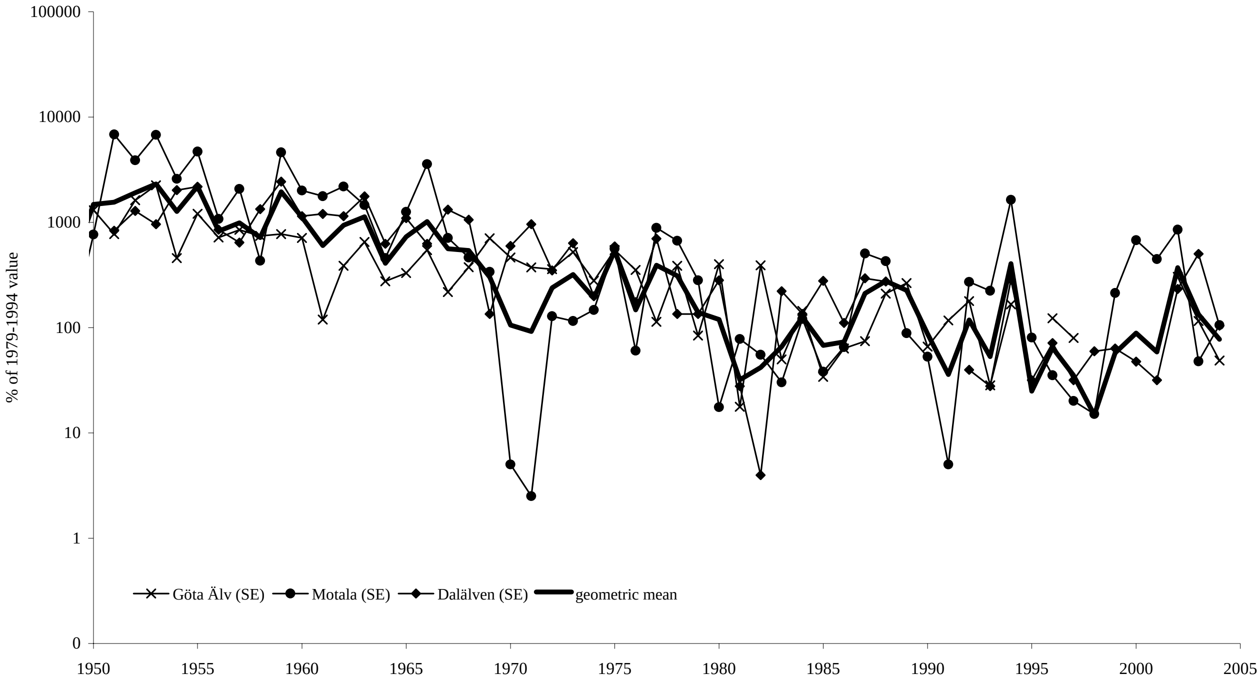

Figure 2.1.2. Time-series of monitoring yellow eel recruitment (older than one year) in European rivers, for which data are reported for 2004. Each series has been scaled to the 1979–1994 average.

Table 2.1.1 Recruitment data series. Part 1. Scandinavia and British Isles. The data units vary between data series; details are specified in Annex 4.

	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	26.2	338.8	58.6		-	1000	112	0.16	5.1
2003		261	44.13	19	126.7		-	1010	580	0.378	19
2004		125	5.0	42	26.4		-	308	269	0.057	10

Table 2.1.1 Recruitment data series; continued. Part 2: Mainland Europe. The data units vary between data series; details are specified in Annex 4.

	NL	B	F	F	F	F	F	E	P/E	It
	Den-Oever	IJzer	Vilaine	Loire	Gironde (CPUE)	Gironde (Yield)	Adour	Nalon	Minho	Tiber
1950	6.92			86						
1951	13.84			166						
1952	89.37			121						
1953	13.97			91				14,529		
1954	20.99			86				8,318		
1955	28.82			181				13,576		
1956	7.58			187				16,649		
1957	17.20			168				14,351		
1958	55.22			230				12,911		
1959	30.26			174				13,071		
1960	22.87			411				17,975		
1961	39.62			334				13,060		
1962	91.79			185				17,177		
1963	131.13			116				11,507		
1964	40.95	3.7		142				16,139		
1965	85.94	115.0	5.0	134				20,364		
1966	20.63	385.0	4.0	253				11,974		
1967	31.46	575.0	9.0	258				12,977		
1968	21.66	553.5	12.0	712				20,556		
1969	18.37	445.0	10.0	225				15,628		
1970	41.43	795.0	8.0	453				18,753		
1971	18.49	399.0	44.0	330				17,032		
1972	33.20	556.5	38.0	311				11,219		
1973	24.22	356.0	78.0	292				11,056		
1974	27.97	946.0	107.0	557				24,481	1.642	
1975	36.07	264.0	44.0	497				32,611	10.578	11.00
1976	29.33	618.0	106.0	770				55,514	20.048	6.70
1977	62.94	450.0	52.0	677				37,661	36.637	5.90
1978	41.66	388.0	106.0	526				59,918	24.334	3.60
1979	57.84	675.0	209.0	642	19.7	286.2		37,468	28.435	8.40
1980	28.92	358.0	95.0	525.5	25.9	404.8		42,110	21.32	8.20
1981	24.72	74.0	57.0	302.7	20.0	332.2		34,645	54.208	4.00
1982	15.59	138.0	98.0	274	15.0	123.3		26,295	16.437	4.00
1983	10.43	10.0	69.0	259.5	13.6	80.3		21,837	30.447	4.00
1984	14.02	6.0	36.0	182.5	19.2	82.0		22,541	31.387	1.80
1985	15.08	13.0	41.0	154	9.6	64.5		12,839	20.746	2.50
1986	15.83	26.0	52.6	123.4	10.6	45.2	8	13,544	12.553	0.20
1987	6.17	33.0	41.2	145	14.0	82.4	9.5	23,536	8.219	7.40
1988	4.43	48.0	46.6	176.6	10.9	33.0	12	15,211	8.001	10.50
1989	3.04	30.0	36.7	87.1	7.2	80.0	9	13,574	9.000	5.50
1990	3.66	218.2	35.9	96	5.6	48.1	3.2	9,216	6.000	4.40
1991	1.12	13.0	15.4	35.7	7.7	64.0	1.5	7,117	9.000	0.80
1992	2.96	18.9	29.6	39.3	3.7	41.7	8	10,259	10.000	0.60
1993	2.96	11.8	31.0	90.5	8.2	69.4	5.5	9,673	7.600	0.50
1994	4.93	17.5	24.0	94.6	8.7	45.8	3	9,900	4.700	0.50
1995	6.98	1.5	29.7	132.5	8.2	73.2	7.5	12,500	15.200	0.30
1996	7.82	4.5	22.4	80.8	4.8	30.7	4.1	5,900	8.700	0.10
1997	12.70	9.8	22.6	70.8	6.5	50.5	4.6	3,656	7.400	0.10
1998	2.27	2.3	17.5	60.7	4.3	25.0	1.5	3,273	7.400	0.13
1999	3.53		15.3	86.9	7.5	44.1	4.3	3,815	3.800	0.06
2000	1.73	17.85	14.2	79.9	6.6	25.1	10	1,330	1.200	0.07
2001	0.57	0.7	8.1	30	1.9	9	4	1,285	1.100	0.04
2002	1.15	1.4	16.0	41	4.9	36.8	6	1,569		0.02
2003	1.54	0.539	8.9	55				1,231		0.02
2004	1.52	0.381	7.0	20				506		0.03

2.2 Trends in stock and Yield

The FAO maintains a database of eel fishing landings. Additionally, ICES maintains a database of landings of marine, Atlantic eel fishing landings. Since the data in the ICES database exclude the inland yield, preference is given to the FAO data. However, in the past years, major inconsistencies between the FAO and Working Group estimates were observed, indicating a major revision of the databases is required. In the period before the meeting, official data and previous working group estimates have been circulated, and inconsistencies discussed in detail. The Country Reports, listed in Annex 4 present full details on the information available in different countries. In order to sort out the differences between official databases and working group estimates, a special meeting was organised after the working group meeting. During this meeting, the reasons behind data inconsistencies were analysed. See Annex 2 for details. It was concluded that a major review of the official data was not yet within reach, due to the many inconsistencies within and between countries. The data review was referred back to the Working Group, with the specific recommendation to further this process, by requesting individual countries to address the problems listed in Annex 2, in their national reports to the Working Group for the coming year. Following this revision, the Working Group should then consider whether to recommend revisions to the national data series, as reported to FAO and ICES.

2.3 Trends in re-stocking

Data were obtained from a number of countries, separate for glass eels and for young yellow eels. The size of 'young yellow eel' varies between countries. Most data available were on a weight base. Weights were converted to numbers, using estimates of average individual weights of the eels re-stocked. These were 3.5 g for Denmark, 33 g for the Netherlands, 20 g for (eastern) Germany, and 90 g for Sweden. An overall number of 3000 glass eels per kg was applied.

An overview of data available up to 2004 is compiled in Tables 2.3.1 and 2.3.2

Table 2.3.1 Re-stocking of glass eel. Numbers of glass eels (in millions) re-stocked in (eastern) Germany (D east), the Netherlands (NL), Sweden (S), Poland (PO), Northern Ireland (N.Irl.) and Belgium (Flanders).

	D EAST	NL	SE	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				
1952	0.0	16.9		17.6		
1953	2.2	21.9		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		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			7.7	
1980	39.7	24.8			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			13.8	
1986	23.8	10.5			25.4	
1987	26.3	7.9			25.8	
1988	26.6	8.4			23.4	
1989	14.3	6.8			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	2.4		11.1	0.5
1997	0.38	2.3	2.5		10.9	0.4
1998	0.3	2.5	2.1		6.2	0.0
1999	0.0	2.9	2.3		12.0	0.8
2000	0.0	2.8	1.3		5.4	0.0
2001		0.9	0.8		3.04	0.2
2002		1.6	1.4		6.6	0
2003		1.6	0.6		9.2	4.5
2004		0.3	0.8		3.0	0

Table 2.3.2 Re-stocking of young yellow (bootlace) eel. Numbers of young yellow eels (in millions) re-stocked in (eastern) Germany (D east), the Netherlands (NL), Sweden (S), Denmark (DK) and Belgium (Flanders).

	D EAST	NL	SE	DK	FLANDERS
1945					
1946					
1947		1.6			
1948		2.0			
1949		1.4			
1950	0.9	1.6			
1951	0.9	1.3			
1952	0.6	1.2			
1953	1.5	0.8			
1954	1.1	0.7			
1955	1.2	0.9			
1956	1.3	0.7			
1957	1.3	0.8			
1958	1.9	0.8			
1959	1.9	0.7			
1960	0.8	0.4			
1961	1.8	0.6			
1962	0.8	0.4			
1963	0.7	0.1			
1964	0.8	0.3			
1965	1.0	0.5			
1966	1.3	1.1			
1967	0.9	1.2			
1968	1.4	1.0			
1969	1.4	0.0			
1970	0.7	0.2			
1971	0.6	0.3			
1972	1.9	0.4			
1973	2.7	0.5			
1974	2.4	0.5			
1975	2.9	0.5			
1976	2.4	0.5			
1977	2.7	0.6			
1978	3.3	0.8			
1979	1.5	0.8			
1980	1.0	1.0			
1981	2.7	0.7			
1982	2.3	0.7			
1983	2.3	0.7			
1984	1.7	0.7			
1985	1.1	0.8			
1986	0.0	0.7			
1987	0.0	0.4		1.6	
1988	0.0	0.3		0.8	
1989	0.0	0.1		0.4	
1990	0.1	0.0	0.8	3.5	
1991	0.1	0.0	0.9	3.1	
1992	0.1	0.0	1.1	3.9	
1993	0.2	0.2	1.0	4.0	0.2
1994	0.2	0.0	1.0	7.4	0.1
1995	0.7	0.0	0.9	8.4	0.1
1996	0.9	0.2	1.1	4.6	0.1
1997	1.5	0.4	1.1	2.5	0.1
1998	1.2	0.6	0.9	3.0	0.1
1999	1.1	1.2	1.0	4.1	0.1
2000	1.0	1.0	0.7	3.8	0.0
2001		0.1	0.4	1.7	0.0
2002	0.4	0.1	0.3	2.4	
2003		0.1	0.3	2.2	
2004		0.1	0.1		

2.4 Trends in aquaculture

Aquaculture of the European eel ranges from highly industrialised, indoor facilities in northern Europe, through extensive culture in artificial ponds in southern Europe, to re-stocking of foreign glass eel in semi-natural outdoor waters for fisheries in northern Europe. All aquaculture depends entirely on seed stock derived from the wild population, since artificial reproduction fails in the young larval stage. Additionally, aquaculture plants are used for quarantine of foreign glass eel to be re-stocked in outdoor waters (e.g. Sweden) and transport of partly grown eels between aquaculture and fisheries occurs in and between countries (France, Italy). Obviously, the distinction between aquaculture and fisheries is hard to define.

There is no consistent long running time series for aquaculture production. Data are available from FAO, from the Federation of European Aquaculture Producers, from previous meetings of the working group and from Kamstra (1999). An overview of the estimates is compiled in Table 2.4.1

The aquaculture production in Europe is concentrated in Denmark, the Netherlands and Italy. The aquaculture in Denmark and the Netherlands is technically highly developed and produces an increasing part of the total, while Italy has intensive as well as extensive culture systems, the latter having a declining production. Data show an upward trend in the period before 2000, followed by a stable level.

Table 2.4.1. Aquaculture production of European eel in Europe and Japan. Compilation of production estimates (tonnes) derived from reports of previous WG meetings, FAO, FEAP and others. Data for Sweden and the Netherlands have been revised.

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Japan		3000															10000			
Sum EU	1950	2229	3448	4729	5517	5159	6667	6098	6818	7721	7689	8935	9031	10646	11059	10839	10510	8435		
Czech. Rep.									2	4	4	3	3	3	1	1	1	1		
Hungary					90	39	73	33		50		50			19	19				
Croatia								7	5	5	7	6	7							
Yugoslavia	44	52	48	49	19	10	5	1	8	2	9	5	5	5	6	6	5	4		
Macedonia									1	0	70	83	60	72	60	50	32			
Turkey																				
Greece			6	4	10	54	94	132	337	341	659	550	312	500	500	300	600	735		
Italy	2600	2800	4200	4600	4250	4500	3700	4185	3265	3000	2800	3000	3000	3100	3100	3100	2750	2500	1900	
Tunisia							150	151	250	260	108	158	147	108						
Algeria					72	53	22	1	0	22	20	17	17	17	22	15	18	20		
Morocco							35	41	68	85	55	55	56	42	27	28	60	28		
Portugal	60	60	590	566	501	6	270	622	505	979	200	110	200	200	200	200				
Spain	15	20	25	37	32	57	98	105	175	134	214	249	266	270	300	425	200	259		
Belgium/Lux.					30	30	125	125	125	125	150	140	150	150	40	20	50	55		
Netherlands				100	300	200	600	900	1100	1300	1450	1540	2800	2450	3250	3500	3800	4000	4000	*4200*
Germany										100	100	100	150	150	150	150	300	160		
UK				20	30	0	0				25		25							
Ireland																	100			
Denmark	18	40	200	240	195	430	586	866	748	782	1034	1324	1568	1913	2483	2718	2674	2000	1880	2050
Sweden	12	41	51	90	203	166	157	141	171	169	160	139	161	189	204	222	273	200	167	170
Norway										120	200	200	200	200						

2.5 Seasonality in eel fishing

In previous reports of the working group, season closure has been advised as a potential management measure to restrict the impact of fishing. Effective season closures have been applied locally in several areas. In recent discussions between managers and stakeholders, however, universal season closures have been mentioned, implemented over larger (or even continent-wide) areas. The Working Group realised that the spatial consistency of fishing seasons had not been addressed before. It was therefore decided to compile data on fishing seasons, for each of the life stages separately. Since no specific request was received to advice on the effect of potentially uniform season closures, no interpretation of the data is presented.

2.5.1 Seasonality in glass eel fishing

Most data presented are from fisheries; the Dutch data refer to experimental fishing, while the Irish data are derived from non-commercial fishing for local stock enhancement.

Glass eel fisheries all around Europe show a temporal distribution from October till May. The catch distribution follows a south to north gradient. In the southern areas the season starts in November (Basque country) whereas only in March, in northern areas (Northern Ireland). It ends around February in the south, while in May in the north (Table 2.5.1.1). All the intermediary areas follow a regular progressive evolution of the season from these two extreme patterns (Figure 2.5.1.1).

Table 2.5.1: Seasonality in glass eel fishing. Catch per month, in percentage of annual total.

Country	Area	Lat.	Oct	Nov	Dec	Jan	Feb	Mar	April	May	Jun
NIR(UK)	Bann estuary	55.4	0	0	0	0	0	40	60	0	0
NIR(UK)	Irish Sea Estuaries	54	0	0	0	0	0	40	60	0	0
NL	L.Ijsselmeer (CPUE)	53	0	0	0	0	0	9	55	36	0
IR	Erne & Shannon	53	0	0	0	0	33	33	33	0	0
FR	Vilaine estuary marine fishermen	48	0	0	5	22	44	27	1	0	0
FR	Loire	47	0	0	14	26	35	23	3	0	0
FR	Loire estuaire et aval fluvial fishermen	47	0	0	3	27	39	24	5	1	0
FR	Gironde zone mixte	45	0	3	6	13	42	33	2	0	0
FR	Pibalour estuaire maritime	45	0	4	19	30	27	19	1	0	0
FR	Adour fluvial fishermen	44	0	23	27	27	19	4	0	0	0
ES	Basque Country	43	0	12	39	35	12	2	0	0	0

The mean length of the fishing season is about 4 months, but it last up to 5 months in the southern regions and down to only 2 months in the northern areas.

Modes in catch quantities usually occur in a single month, in which more than 30% of the total catch is taken (exception in the Adour: 27.4%). This month is December in the south (Basque Country and Adour), January in the Gironde estuary, February in the Gironde, in the Loire and in the Vilaine, in April in IJsselmeer, in the Irish Sea estuaries and in the Bann estuary.

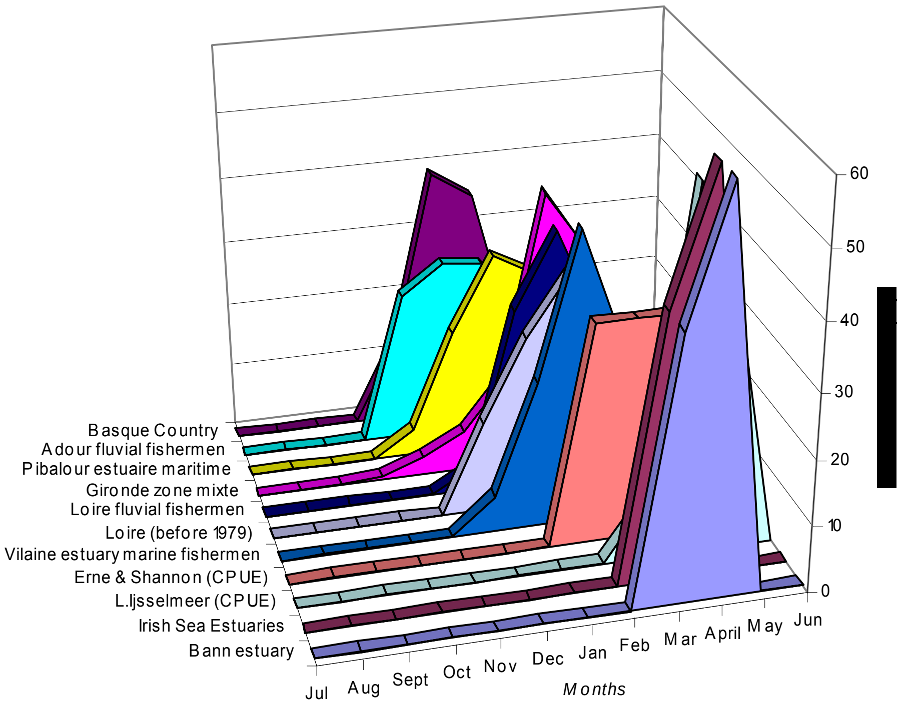

Figure 2.5.1.1. Glass eel seasonality pattern.

2.5.2 Seasonality in yellow eel fishing

All the data processed are related to fisheries, except for experimental fishing in Burrishoole (Ireland) in a yearly sampling from March to October showing a fisheries independent distribution with a maximum value of 18% of the total catch in June and July (Table 2.5.2; Figure 2.5.2).

The fisheries all around Europe have a seasonal pattern following an initial period of increasing catch, a period of maximum catch for a few months, finally decreasing towards the end of the year. This final decrease is not seen in the Swedish stat area n 23, probably because of yellow eel bycatches taken in the silver eel fishery during the winter season.

There is no strong latitudinal influence on the seasonality of yellow eel fisheries. In general, the fisheries start in April in all the studied countries. In river systems where there are several kind of fisheries such as for glass eel, lamprey and shad, there is an inter-relationship among them: the yellow eel fishery becomes important when the others finish. This might explain the delay between the Gironde estuary and the Gironde upstream zone-mixte.

There are two different patterns on yellow eel fisheries: the unimodal distribution with a short mode lasting just a month which represents more than 25% of the total catch, increasing to the 40% in the northern areas (see Sweden, ICES Stat area 27). This mode occurs from May to September. It seems that there is a geographical pattern, having an early maximum generally in the south and a later one in July in the North, and a temporal variation in IJsselmeer showing an evolution from an early pick in the beginning of the season (May) to the end of the season (September) with a transitional period in between those years.

Where the maximum values are distributed over more than one month (from 2 months to 4 months) each month takes between 14% and 21%. This usually includes July and/or August. The end of the season may occur abruptly or can take a longer time, starting usually from September or October.

Table 2.5.2. Seasonality in yellow eel fishing. Catch per month, in percentage of annual total.

Country	Area	Lat.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
SE	ICES stat area 30	62	0	0	0	0	16	29	35	15	5	0	0	0
SE	ICES stat area 27	58	0	0	0	1	9	18	43	13	9	6	0	0
SE	ICES stat area 20	57	0	0	0	1	7	18	25	16	18	14	2	0
SE	ICES stat area 21	56	0	0	0	0	16	20	19	14	15	13	3	0
DK	Freshwater	55	0	0	0	7	17	6	17	21	25	5	1	0
DK	Coastal ICES stat area 21 to 24	55	0	0	0	3	13	8	19	21	14	14	6	2
DK	Fjord	55	0	0	1	13	13	10	21	22	10	6	2	1
NIR(UK)	L Neagh	55	0	0	0	0	10	20	20	20	20	10	0	0
SE	ICES stat area 23	55	0	0	0	1	8	10	9	11	10	24	25	1
SE	ICES stat area 25	55	0	0	0	3	11	13	19	29	12	9	4	1
IR	Burrishoole saline	54	0	0	6	8	14	18	19	16	12	8	0	0
DE	shallow lakes	52	1	0	1	10	9	12	21	18	11	8	8	1
NL	L.Ijsselmeer, early season	52	0	0	0	13	24	16	10	13	13	9	1	0
NL	L.Ijsselmeer, average season	52	0	0	0	6	17	16	18	19	16	7	1	0
NL	L.Ijsselmeer, late season	52	0	0	0	4	6	7	11	16	32	23	1	0
FR	Rhin	50	0	0	1	4	6	13	24	23	9	9	6	4
FR	Loire estuaire fluvial fishermen	47	0	0	3	6	18	14	14	18	16	7	4	0
FR	Gironde zone mixte	46	1	3	4	6	7	15	16	15	18	13	3	1
FR	Dordogne amont	45	0	1	3	11	34	27	10	5	3	3	2	1
FR	Dordogne aval	45	0	0	12	6	19	24	19	15	4	1	0	0
FR	Garonne amont	45	0	0	0	0	0	5	23	23	21	13	13	2
FR	Gironde estuaire	45	0	1	4	11	22	20	11	8	9	8	5	1
FR	Garonne aval	45	0	0	0	0	0	0	28	16	32	19	6	0

2.5.3 Seasonality in silver eel fishing

The data set include experimental data (UK), trap counts (Burrishoole, Ireland) and fisheries catches (Figure 3).

The most significant variation occurs at the beginning of the season. The season starts in April (NL IJsselmeer average (female) catches) in May (DK Fjord, SE Vänern, SE Hjalmaren, SE Mälaren), in June (SE Vättern), or in July (SE ICES stat area 27). These early migrations are related to the spring flow in the northern areas like DK Fjord and the SE ICES stat area 21. Catches later in the summer till autumn occur in the southern area, in August (UK Leven, IR Ireland) in September and October (in France).

The mode in monthly catch ranges between 25% and 60% of the annual catch, in August in the northern areas, in September and / or in October in the south.

Table 2.5.3. Seasonality in silver eel fishing. Catch per month, in percentage of annual total.

Country	Area	Lat.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
SE	ICES stat area 30	62	0	0	0	0	1	26	27	34	12	1	0	0
SE	stat area 29N	59	0	0	0	0	0	0	28	55	17	0	0	0
SE	Hjälmaren	59	0	0	0	2	20	15	16	28	16	3	0	0
SE	Mälaren	59	0	0	0	0	12	12	21	27	22	6	1	0
SE	Vänern	59	0	0	0	2	10	12	20	24	21	10	2	0
SE	ICES stat area 27	58	0	0	0	0	0	1	13	37	35	13	1	0
SE	Vättern	58	0	0	0	0	0	13	23	28	24	11	0	0
SE	ICES stat area 20	57	0	0	0	0	3	8	12	71	0	6	0	0
SE	ICES stat area 21	56	0	0	0	0	26	15	25	2	5	6	21	0
DK	Coastal ICES stat a	55	0	0	0	0	0	0	0	2	26	46	21	5
DK	Fjord	55	0	1	0	0	8	3	5	4	26	24	10	17
SE	ICES stat area 24	55	0	0	0	0	0	0	0	8	43	23	21	5
SE	ICES stat area 23	55	0	0	0	0	0	0	0	0	6	31	41	22
SE	ICES stat area 25	55	0	0	0	0	0	0	3	15	45	28	8	0
IR	Burrishoole, early	54	0	0	0	0	0	0	0	14	20	59	7	0
IR	Burrishoole, average	54	0	0	0	0	0	0	0	7	22	53	16	2
IR	Burrishoole, late	54	0	0	0	0	0	0	0	2	7	63	26	2
NIR(UK)	L Neagh	54	5	0	0	0	1	2	2	10	25	25	25	5
UK	R. Leven, early	54	0	0	0	0	0	0	0	14	46	35	6	0
UK	R. Leven, average	54	0	0	0	0	0	0	0	7	7	59	11	16
UK	R. Leven, late	54	0	0	0	0	0	0	0	6	13	27	51	2
IR	Ireland	53	0	0	0	0	0	0	0	10	30	40	20	0
NL	L.Ijsselmeer, early	52	0	0	0	0	0	0	2	29	41	27	1	0
NL	L.Ijsselmeer, averag	52	0	0	0	0	0	0	2	14	49	31	3	0
NL	L.Ijsselmeer, late	52	0	0	0	0	1	1	1	3	37	53	3	1
NL	L.Ijsselmeer, female	52	0	0	0	12	3	7	0	29	28	16	4	0
FR	Loire aval fluvial fish	47	0	0	0	0	0	0	0	0	0	45	27	28
FR	Loire moyenne	47	0	0	0	0	0	0	0	0	0	60	19	21

2.5.4 Seasonality in combined yellow and silver eel fishing

This category comprises those data for which no distinction between the yellow and silver eel was available(Figure 4). They show the spring season for yellow eel as well as the autumn season for silver eel, as discussed above.

The most important autumn catches in France are seen in Loire, Seine and Saone and in the Rhone in from October to December.

Table 2.5.4: Yellow eel and silver eel

Country	Area	Lat.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
DE	Elbe	53	0	0	0	2	16	16	12	18	16	13	6	1
UK	R. Test, early	51	0	0	0	0	4	14	13	30	4	14	21	1
UK	R. Test, average	51	0	0	0	0	7	10	14	18	10	14	22	5
UK	R. Test, late	51	0	0	0	0	8	9	6	16	15	29	8	10
FR	Seine & Somme	50	2	2	7	9	14	10	8	13	9	21	3	1
FR	Loire aval fluvial fishermen	47	1	1	2	5	8	8	6	5	3	32	24	6
FR	Loire moyenne	47	1	1	5	5	10	7	6	4	3	47	8	3
FR	Charentes fluvial fishermen	46	6	7	11	16	20	16	8	3	6	5	3	1
FR	Saone aval	45	3	4	6	12	10	22	12	9	3	6	4	8
FR	Adour fluvial fishermen	43	0	2	7	23	24	18	8	7	2	4	6	0
FR	Rhone aval	43	0	0	2	7	18	26	18	10	6	13	0	0
FR	Rhone delta fluvial fishermen	43	3	1	1	4	7	10	14	15	14	9	12	9

3 Objectives, targets and management measures

3.1 Introduction

There are fundamental differences in biology and our knowledge base between the eel and almost all other (marine) fish species to which international management systems are applied. The advice on the status of the eel stock, and the management actions required, so far has largely paralleled the advice given for the other species. However, the case of the eel is aberrant, in the sense that the eel stock is extremely scattered over a multitude of inland waters with divergent characteristics, and that anthropogenic impacts, such as barriers in migration ways, pollution, habitat loss, etc. presumably have an impact on the eel stock of a comparable magnitude as exploitation. In addition, recent evidence suggests that the relationship between spawning stock and recruitment might show depensation. In this Section, the objectives of sustainable management are reviewed with respect to the eel, and the complications arising from the other impacts, and from potential depensation, are integrated in this conceptual framework.

3.2 Main objectives

There is no centrally formulated long term management objective for the European eel population, and no proactive fisheries management system operating on a stock wide basis. A logical scientific objective is the maintenance of a population which is capable of sustaining itself within the range of anthropogenic and natural pressures it faces. Both spawning stock biomass and recruitment have declined over recent decades. Scientific advice has been that the population is outside safe biological limits, that fishery and anthropogenic impact should be reduced to the lowest possible level and that a recovery plan be developed. (ICES, 2001; 2002).

Conventional fishery management for species breeding in marine waters is based on pooling annual estimates of recruitment (R) and catch at age for all stock subunits into a combined virtual population analysis, resulting in an annual estimate of Spawning Stock Biomass (SSB) and continuous refinement of a known stock-recruitment relationship. Fishing effort levels and catches are then adjusted annually in an attempt to return or maintain the stock to within sustainable levels. Such an analysis is currently not possible for eel. Data on which management advice can be based are limited to annual indices from a number of sites for recruitment, measured as glass eel catch, immigration data (see Figures 2.1.1 and 2.1.2), and Catch per Unit Effort (CPUE) in yellow eel fisheries.

The decline in the recruitment data series is the basis for the current advice. Only recently has a tentative SSB – R relationship been postulated for European eel, based on the known recruitment data series and the assumption that SSB is proportional to continental landings (see Figure 3.2.1)**.** The shape of this postulated relationship suggests that eel spawning and recruitment dynamics may follow an asymptotic stock-recruitment relationship, in which reproductive success is strongly impaired below a certain threshold spawning stock size, which might be the case since 1980 (Dekker 2004).

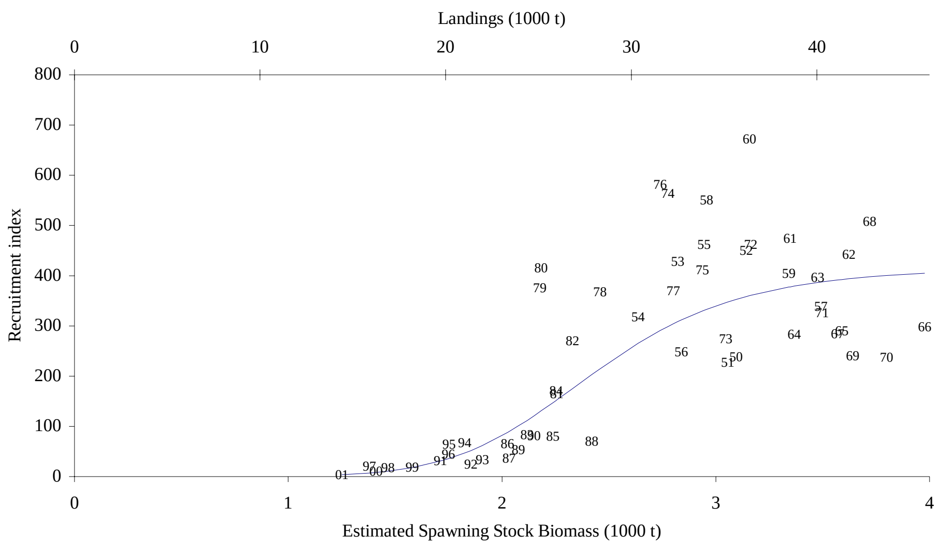

Figure 3.2.1. Estimated stock-recruitment relationship for the European eel. Numbers indicate the year of recruitment. The spawning stock is assumed proportional to the landings from the continental stock (after Dekker 2004).

The currently identifiable milestones leading from the current decline through a recovery plan to ultimate sustainable management are:

Immediate:	Halt recruitment decline
Next	Reverse trend to upward (rebuilding)
Then	Bring the stock to a sustainably exploitable state.

A management framework has been proposed (ICES/EIFAC WGEel 2001 onwards), based on reducing fishing and other anthropogenic mortality, with the following reference points:

A *provisional limit reference point* of 30% SPR

And a second, *more precautionary reference point* of 50% SPR considering the many uncertainties in eel biology and management.

3.3 Pristine state

It is important to note that these SPR reference points do not mean an actual ratio of spawner to recruit, but rather a notional point on an SSB to R relationship. These %SPR reference points are conventionally applied with harvest rate models, in which the unexploited state can be estimated, irrespective of absolute levels of recruitment. In the case of eel, current knowledge is insufficient to allow this approach, predominantly since anthropogenic impacts other than fisheries have an impact on the stock. Therefore, the reference points proposed for eel relate to a percentage of spawner production in a notional “pristine” or “virgin” state. No explicit definition has so far been given of what this pristine state might be for eels. At one extreme it can be defined as a stock level arising from a continental population growing in a habitat free from all anthropogenic impacts and supplied with optimal recruitment levels. This notional pristine state can only be set on a regional, preferably catchment, basis and may in the most data rich cases refer to known historical data. On the other hand, for data poor catchments this level may only be derivable theoretically or by modelling. This theoretical approach requires that decisions are made as to what point in history is selected as the reference point. A SPR level referenced back to a pre-industrial era will be extremely difficult to attain, given the large loss of freshwater habitats. However, a pragmatic, historical level need not be a sustainable level. There is considerable overlap between this discussion on eel management and the process of defining reference conditions required in the Water Framework Directive. Further convergence of these two needs is likely to present a useful way forward.

3.4 Dual approach for exploitation and remaining factors

We suggest that in the context of fisheries management an appropriate provisional starting point for a definition of a pristine state is the spawner production from currently available habitat with no fishery and at the pre-1980s average recruitment level. Within the additional context of habitat management and/or restoration the definition of pristine should coincide with Water Framework Directive WFD requirements referring to, *inter alia,* a situation without upstream or downstream migration restriction. The use of WFD requirements as a means to aid eel population management has the inherent assumption that EU member states interpret the objective of “good ecological status” as incorporating a requirement for full connectivity of eel habitat. The two contexts of habitat and fisheries management requiring a definition of pristine state should be seen in combination, with synergistic effects, but compliance should be determined according to the impacts managed as well as by monitoring for local and regional stock level improvement. A stepwise 5 point approach to habitat management and improvement to aid stock recovery was proposed by ICES (2002) (i.e. full use of existing habitat; restore habitat where easily done; full use of existing recruitment; restore historical habitat; restore pristine conditions).

This dual approach (fisheries vs. habitats) solves the problem with evaluation of compliance against targets set for separate elements of a management plan. This constitutes a pragmatic approach to the complex problem of managing both fisheries and habitats, that is: mortalities and absolute biomasses. In the long run, these two, separate approaches will have to be integrated into a single, comprehensive approach. However, it is felt that separate handling of the two issues facilitates rapid derivation of target values, and more rapid implementation.

For arbitrarily defined working targets such as these, the evaluation process must enable not only an assessment of whether or not the target is met, but also of whether or not the target itself is appropriate. Given the specificity of eel biology and ecology, targets required may differ from default levels taken directly from experience of managing other species. The target levels now set at 30 or 50% SPR may have to be revised if the expected recovery is achieved before they are met, or not achieved.

3.5 Depensation and re-stocking

WGEEL first proposed %SPR reference points in 2001, following the decline in recruitment first noted in the 1980s. Previous advice from the Working Group has been based on the view that depensation (see below) may not be an issue and that recovery can be expected, even from very low levels of recruitment and SSB.

While the shape of the postulated SSB – R relationship suggests that eel spawning and recruitment dynamics may follow a similar type of relationship to other fish species, (see above) the recruitment data shows a recent decline which is potentially much faster than being simply proportional to the SSB decline. This indicates a possible depensation or “Allee effect” (Allee 1931**)** at low population levels, namely where negative feedback effects move stocks to a very low level or towards extinction. Should SSB fall to levels where spawning becomes unsuccessful due to low densities on spawning grounds, depensation could occur.

The possibility, now put forward, that depensation might have been occurring for up to 20 years, was not considered by the Working Group before. Continued historically low levels of recruitment since 2000 further reinforce the need to consider this possibility. There is now a requirement to consider that depensation may be a reality and that we have reached a minimum viable level of SSB. This conclusion is in line with the basis of previous advice, namely that in the presence on uncertainty, the precautionary principle applies (ICES, 1997).

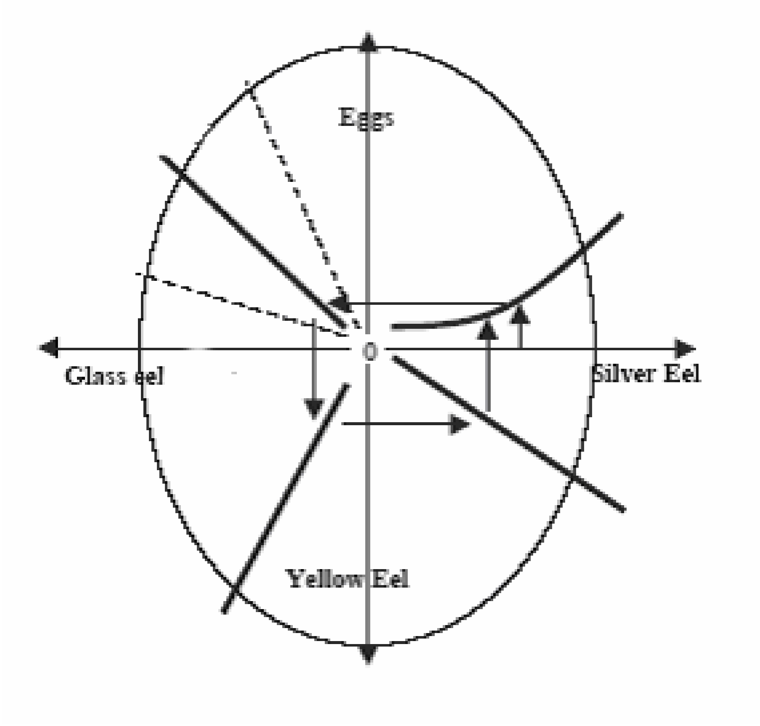

Figure 3.5.1 Production trajectory among the life stages of eel. Production trajectory of stages proceeds in a counter-clockwise manner from silver eels →eggs→glass eel → yellow eels → silver eels. The oval highlights portion of this Paulik diagram corresponding to low silver eel production. This panel shows scenario of low spawning escapement, followed by a depensatory response. (From ICES, 2001adapted).

The issue of possible depensation triggers a new and heightened level of precautionary advice. The critical management objective in a depensation scenario is to return SSB to the level above which recruitment increase results from increased SSB. It is no longer sufficient to manage on the basis of fishing mortality restriction alone. In this situation the logical action is to stop all anthropogenic causes of mortality and in addition to consider re-stocking.

Preliminary modelling results discussed in Annex 3 indicate that a full closure of fishing may be insufficient to achieve an immediate increase in silver eel escapement large enough to escape depensation in the reproductive phase. A further decline in the potential maximum escapement achievable from the continental stock is also inevitable in the medium term as the known recruitment drop in the recent decade feeds through to derived silver eels. The probability of achieving large habitat improvements in the short term is low. In this situation, stocking with a view to maximising spawner output from existing glass eel stock can be proposed as a potential precautionary measure. There are a number of essential preconditions, first of all that demonstrable surplus exists in some local glass-eel stocks, that this is available for use, and that anthropogenic mortality in the recipient areas is minimised.

3.6 Risks involved in re-stocking

The risks involved in re-stocking have been discussed at length by ICES (2000). The major issues concerned are the following:

Movement and stocking of fish involves a risk of decreased genetic variability. Traditionally the European eel has been regarded as a single, panmictic stock (ICES, 2004, WGAGFM). The results of microsatelite analysis (Wirth and Bernatchez 2001)) have challenged this, indicating a gradual change in genetics across the geographic range. Later research on material from the full range of the species (Dannewitz, Maes, Johansson, Wickstrom, Volckaert and Jarvi, submitted) has made it likely that this result may be due to a temporal trend in genetic setup rather than a geographic difference. In that case the stock is indeed panmictic and relocation involves no risk of genetic effects.

Even in a genetically homogenous population, movement of eels may disrupt the migration behaviour. If there is a phase during the glass-eel stage when cues are imprinted then the spawning migration of relocated eels may be impossible or compromised (Westin 1990). In that case the effect of stocking will be absent or less than expected.

The spreading of diseases is always a risk when fish are transported and introduced in new areas. There are known ways of minimising this by the use of quarantines etc.

A further consideration is the observation that the sex ratio of eels varies according to stock density in a catchment. The factors involved in sex determination and the optimum sex ratio of the SSB are unknown, but deliberate manipulation of sex ratio may be an advantage rather than a risk.

In view of these risks, ICES (2000) recommended to prefer seed-stock from within or from nearby river systems, when applying re-stocking as a stock enhancement measure. The potentially beneficial effect of stock enhancement on the production of spawner escapement was noted, but given the (un-quantified) risks involved, a precautionary and risk-averse strategy (enhancement of spawner escapement by reduction of exploitation and other anthropogenic impacts) was preferred.

3.7 Choosing between risks

The current state of our knowledge is now characterised by a balance of unknown risks.

On the one hand is the hypothesis, that the recruitment decline observed since 1980 might be the consequence of depensatory processes in the reproductive phase. Most recent data support this, rather than the alternative hypothesis of environmental variation (in ocean climate) causing increased juvenile mortality, but due to the absence of sufficiently adequate proof, no final judgement can be made. If depensation occurs, a rapid (near)-extinction of the stock is foreseen. Provisional calculations (Annex 3) indicate that a full cessation of exploitation is inadequate to restore silver eel escapement immediately to levels at which depensation is unlikely to occur. Re-distribution of incoming recruitment from areas of highest abundance (core of the distribution area and lower river stretches, where overabundant population leads to density dependent mortality) into lower abundance areas, will potentially increase the overall production of spawners above the hypothesised depensation threshold.

On the other hand, the risks involved in re-stocking, notably: potential genetic pollution; possible transfer of diseases and parasites; re-stocking possibly changing sex ratios; and absence of positive effects due to unfit behaviour of re-stocked eels. The evidence for genetic effects is equivocal. The spread of diseases and parasites can be prevented by quarantine procedures, in theory. It is doubtful, whether re-stocking without positive effects on the spawning stock due to behavioural misfits, has any effect on the natural stock. At the bottom line, although some of the potential negative effects can be remedied, the overall risk involved in re-stocking is unknown, and quantification of the risk within a limited time frame is rather unlikely.

Using re-stocking of glass eel as one of a suite of stock rebuilding measures takes certain risks, but not doing so faces the risk that might continue to collapse towards (near)-extinction. The precautionary approach, in which preference is given to the most risk-averse management strategy, does not tip the scale in either direction, since both ends involve un-quantified risks. As a consequence, the desirability of restocking programmes as an additional stock protection measure must be re-considered, given the current extremely low recruitment of glass eels over much of their range, and the possibly limited time frame (ca. 5 years) available for enhancement of future silver eel escapement to levels at which depensation is unlikely to occur. In this consideration, the inability to quantify the risks involved must be borne in mind.

3.8 Scientific and management actions needed for implementation of a stock recovery plan

The management actions available for correcting stock decline in European eel and moving towards sustainable exploitation have been discussed in previous Working Group reports and other documents (ICES, 2001; Commission paper COM(2003) 573 final). The proposed actions include

1. Measures to limit exploitation by fisheries
   - 1.1. Prohibition of fishing
   - 1.2. Total allowable catches or quotas
   - 1.3. Gear controls
   - 1.4. Landing size limits
   - 1.5. Closed seasons and/or areas
   - 1.6. Licensing of fishermen and dealers
2. Measures regarding eel Habitat re-creation
   - 2.1. Ensuring habitat accessibility
   - 2.2. Reduction of habitat loss
   - 2.3. Ensure habitat and water quality
   - 2.4. Ensure downstream migration
3. Controls on non-fishery mortality
   - 3.1. Turbine mortality
   - 3.2. Predation
   - 3.3. Disease and contamination
4. Restocking measures
   - 4.1. Using glass eels from sources where there is still a demonstrable surplus
   - 4.2. Using eels from aquaculture production (aquaculture being totally dependent on wild seed)

3.9 Time frames for rebuilding measures to take effect

The current stock, fishing yield and spawner production are derived from glass eel that recruited to the continental stock in the mid-1990s. Glass eel abundance in the mid-1990s was around 10% of former levels. Subsequent recruitment has been much lower, with values since 2000 ranging between 1 and 5%. A further decline in stock, yield and spawner production is therefore expected in the coming years; based on an average life span, a reduction in spawner escapement is expected around 2009, which might translate into a further decline in recruitment two years later. Swift precautionary action to protect the production of spawners is required, becoming effective before the recruitment decline in 2000 translates into a corresponding decline of spawner production, in a period of ca. five years.

There is considerable variation in time from glass eel recruit to silver eel emigration, depending largely on temperature, habitat suitability and productivity. At the extremes of the range of the European eel, lifespan from immigrant glass eel to emigrant silver eel ranges from around five to 10 years in the Mediterranean region to in excess of 25 or 30 years at the least productive extremes. This means that measures designed to generate local stock level improvements, for instance by restricting fisheries, restoring access to currently inaccessible habitats, or restocking, will have much more rapid effect in southern Europe than in the areas of longer eel lifespan. Similar measures applied in different areas may have essentially different purposes and outcomes. For example stocking in southern areas could be designed for rapid regeneration of a regional spawning emigration, whereas in long lifespan areas this would be a 20 to 30 year "Insurance policy" aimed at future spawner production. Stock evaluation models must be capable of incorporating the full range of life history strategies in different regions.

Whatever stock enhancement measures are taken, these measures should take place throughout the range of the eel, to insure against the lack of knowledge of possible rates of recovery should oceanic processes prove to be the dominant factor in recruitment decline. In this case, long term "Insurance" measures might be more important than short term, but in the case of continental mortalities being a dominant component, short term measures become more important. Currently, knowledge of the relative importance of the proposed drivers of recruitment decline is so poor that a recovery programme has to cover for both these extreme possibilities.

The history of recruitment decline is such that silver eels now leaving some areas, particularly in the south of the range, are already derived from low recruitment levels following Europe wide declines in recruitment in the 1980s. This is progressively becoming relevant to eels leaving middle and northern parts of the range. Management options based on optimal use of existing silver eel escapement are becoming more limited with time due to age profile and recruitment history. The American fisheries society declaration (Dekker *et al*. 2003) following the Quebec eel symposium in 2003 state that "Opportunities to protect these species (American and European eel) will fade along with the stocks".

3.10 The potential role of oceanic impacts on the eel stock

While the relative contribution of the various possible influences causing stock decline remain unknown, specific focus is necessarily placed on those processes and influences which are potentially manageable. Some authors (e.g. Knights 2003) propose that the over-riding cause of decline is oceanic or climatological, as there is no evident change in known factors – such as habitat, fishing pressure or health status of the stock – that can explain the totality of a drop of recruitment by a factor 5–10 in the last decade (see Dekker 2004 for a comprehensive discussion). This, however, is not a reason for inaction, but rather a driver focusing the need for corrective action on those potential causes of decline which are potentially controllable or correctable by human management action.

3.11 Exploitation control and habitat improvement measures

Just as in the marine spawner to recruit phase, there is severe lack of knowledge of the relative scale of importance of impacts on the freshwater phase. This drives a need for a spread of measures in addition to addressing fishery controls. Some non-fishery factors act in essence like fishery impacts, for instance power turbine mortalities. Others are essentially "habitat restriction" based, such as habitat degradation or access restriction at obstacles. It is important that rapidly acting measures are taken where these are possible, for instance providing access through passes to useful habitat where this is currently blocked, and trapping and transport of elvers upstream and silver eels downstream where the scale and cost of modification to obstacles prevents short term physical modifications.

Market conditions will influence and may limit ability to take measures and vice versa, particularly in the glass eel restocking sector. The effects of measures interact and care must be taken to avoid measures which have detrimental consequences for other potential options.

Existing capability and funding of research and monitoring activity is such that many monitoring authorities are already fully stretched and limited by human resource or other financial restriction. This must be taken into account in proposing measures which will have significant additional cost. There is a natural tendency for management measures to be selected on a least cost basis irrespective of their likely effectiveness.

3.12 Special factors affecting stocked and managed fisheries currently achieving significant spawner escapement

Fisheries supported by supplementary stocking may deviate significantly from their notional "pristine state" and may, through stocking and/or upstream transport of glass eel, achieve higher outputs of spawners in their current managed state than if they were left unmanaged. Fishery activity can support management activity including glass eel transport and import stocking. There is a risk that measures limiting the viability of fisheries to the point where the transport and stocking activity cannot be maintained, could result in a net loss of spawners locally rather than a net gain**.**

Low density freshwater populations tend to produce more females. This may be a natural compensation mechanism by which the eel population is capable of surviving periods of naturally low recruitment. In local management actions, this effect can be used to maximise female spawner escapement, for instance by spreading stocking over as wide a range of productive habitat as possible rather that in one concentrated location. The potential success of such action is based on the usual assumption that female spawning stock is the limiting factor in producing offspring. Alternatively, however, behavioural aspects might require an adequate number of males to be present, in order to perform successful courtship or spawning behaviour.

Nevertheless, the extent of anthropogenic effects on the current stock is such that the stabilisation of the female spawning stock biomass at low stock density can not be used as a reason for failure to take action.

4 Modelling local stock dynamics

4.1 Introduction

In last year's report (ICES, 2004), the WG presented the concept of a Habitat Suitability Index model (HIS), a Reference Condition Model (RCM) with which to assess compliance with biological targets in relation to pristine state, and included a brief discussion on Harvest Rate Models (HRM). None of these was fully worked out, and it was not clear how linkage might be made between them. The group suggested that there is a need to show how we might identify which processes are limiting, how these might be translated into selection and quantitative of advice on management measures, and to clarify the type of monitoring data required to assess status. This can be achieved using HRM focusing on fisheries, though only in relation to exploitation, but neither HIS nor RCM address these issues. Whatever model is used, decision rules are needed to point to the severity of failure, or whether the stock achieves compliance in relation to a target or reference point, and whether and where management is needed (see Section 3).

This Section attempts to detail the features of an "ideal" model, and to provide a template against which those models that are being developed can be tested to see how far we are from achieving this. Descriptions of the methodology and structure of existing models presented at this meeting, their information needs and output are provided in annexes to this report. A more complete overview of relevant modelling approaches is needed to fully aid the future construction of a model.

4.2 Model requirements

The most urgent requirement is for an operating model capable of using monitoring data to assess the degree of compliance with reference points/targets, to indicate the pressures on a population leading to failure, and to quantify the strength of measures needed in relation to exploitation and habitat (e.g. reduction in mortality, increased passage, improved habitat quality). The model also needs to be able to evaluate the effects of implemented measures on stock recovery, through time and in relation to reference points. It should be able to predict changes in size structure and in survival or mortality at size and age (preferably with a spatial component in relation to colonisation front or RCM, for example) and, eventually, spawner escapement. Note that, if the reference point is expressed in terms of spawner escapement, it may be necessary to introduce an index of "quality" of spawners, to account for impacts on reproductive success due to parasites, contaminants etc, thus giving "effective SSB"

The ideal model should be related to mortality at all life stages, identified by size and/or age (at least from glass eel to silver eel escapement), and will be able to use data collected at the various life stages, and several types of data: size structures, presence absence, or densities at different levels of the basin. In evaluating the effects of management measures, the model must be capable of predicting the effects of a change in exploitation level and pattern (mortality at size, age or life stage) or amelioration in habitat, linked through the life stages by the peculiar biological characteristics of eels. (Note that this is more complicated than a similar analysis applied to marine Teleosts, for example, where the only biological parameters considered are usually growth and size at maturity). In relating assessments to targets, a %SPR derived through mortality analysis can be converted into an SSB target by multiplying by levels of recruitment.

The model needs to be capable of being applied uniformally across the European stock area, or at a national or catchment level, operated in a standard way but able to accommodate very different biological conditions as well as different types and quantity of data. It must also be flexible, both to accept sub-model inputs (on habitat quality, for example) and capable of being used in data-poor situations, using proxies for different aspects of stock status (such as mean length of yellow eels), as well as using existing time series to validate both model parameters and output in relation to observed historic stock changes. We also need to ensure that the model can continue to be used in the absence of fishery data (if fisheries are closed), using fishery-independent data collected according to agreed protocols.

Management will need feedback much earlier than the average life span (approx. 11.5 year). It would therefore be useful to relate the output from the model to "checkpoints", giving not only an assessment of stock status in relation to the reference point, but indicating whether changes from the glass eel to silver eel stages fit with what was predicted from either changes in recruitment, fishery management measures or habitat improvement.

It may be also useful in the future if the model has the ability to utilise the results of socio-economic analyses, so that it is possible to carry out a cost-benefit evaluation of different management measures (and therefore their likely acceptability).

4.3 Information needs

By carrying out a sensitivity analysis, it should be possible to indicate which data and parameters are most important for model output and, consequently, what are the most informative data to be collected, and also to indicate the confidence that we have in the output. This should also help to address the question of where is the best place to sample, indicating whether we need population information from representative sites in a whole catchment, if it is possible to provide advice by sampling just the most informative part of the population/life stage, and indicating the need for further research.

Note that it may be necessary to identify and measure two phases of recruitment: of glass eels in relation to spawning success; and of pigmented elvers or small yellow eels in relation to recruitment to the yellow eel population and exploited part of the stock. There may be a linear relationship between these at present low levels of recruitment (an assumption that needs testing?), but probably not at higher levels, due to density dependent processes in the phase in-between. Thus, recruitment of small yellow eels might be the most important measure in many catchments, with or without glass eel fisheries, whilst trends in glass eel recruitment can be measured at the existing (20) index sites, possibly extended into presently uncovered areas such as the Mediterranean and Eastern Baltic.

If information on biological parameters is not available for individual catchments, we can use biological rules (an eel is an eel) to make assumptions on , for example, growth, size at silvering, using temperature or other environmental information to adjust parameters known from catchments with other conditions. On the question of habitat quality, the Group notes that indices are already available from work on salmon conservation limits, linking physical features to juvenile production in Northern Europe(though they will need to be extended into lakes and more lowland habitats, even estuaries, and more southerly regions, e.g. Mediterranean), and for eco-regions and the EU FAME project. The degree of connectivity is also important, and indices of "passability" of elvers and yellow eels upstream and silver eels downstream between reaches are required.

One problem identified in this context is the problem of weighting production or population structure measured in different parts of a catchment, in relation to the productive area of each part (considering the adopted definition of pristine state), and especially in estuaries/marine waters compared to fresh waters. In many systems, the main part of the production of spawners could come from outside freshwater and be very difficult to measure. A similar problem exists for deep areas in the freshwater, especially lakes, and methods such as trawling could be used to measure size structures (or age structures) and estimate densities. In lakes, however, the measurements of productive area enable us to calculate absolute numbers, whereas estuaries are more "open ended" and it may not be possible to provide estimates in many cases.

4.4 Future plans

Most importantly, we need to know how far we are from having a model we can use, because we cannot afford to wait much longer. It is recommended that a workshop is held within the next 6 months, at which the results of intersessional work testing the available models, including modelling concepts not represented within the present Working Group, where at least one good data set will be examined and decisions made as to which features of the various models could be used in an operating model.

5 Monitoring of eel stock and fisheries

5.1 Introduction

Monitoring stocks of European eel in a comprehensive manner to evaluate progress of a stock recovery plan will be a complex process that will require careful planning and a high degree of international cooperation. The unique biological characteristics of this species (trans-Atlantic migrations, panmixia, euryhaline physiology, facultative catadromy, variable growth / maturation, extensive continental and coastal range, etc) and variation in the life-history stages (glass eel, yellow eel, silver eel) exploited in different countries are factors that need to be kept in mind. However, the primary objectives should be to enable stock assessments to be made, as required, at catchment, national and overall European levels. Annual stock assessments, and periodic (5-year e.g.) stock management reviews, will be essential for evaluating the progress of the international stock recovery plan. Likewise, such stock assessments will be necessary for individual governments to determine that compliance with recovery plan catchment or national targets is adequate, as well as to enable the overall progress of the plan to be evaluated. Short-term, medium-term and long-term evaluations will require the focus of the monitoring programmes to be progressively adapted, taking account of life-history traits and future fishery activities. Pilot projects, to refine data acquisition protocols, to test models and in selected catchments are anticipated. A workshop specifically addressing monitoring problems is also recognised as being important to develop practical cost-effective programmes that will be applicable at different stock management levels and throughout the range of the species.

It is important that data on stock trends and mortality factors are representative of the total spawning population(s?).Therefore, special adaptations of monitoring programmes may be required in respect of the non-EU areas. Likewise, special integration of monitoring activities will be appropriate in respect of major marine basins (Baltic, Mediterranean) and larger international river systems. International cooperation in monitoring eel catches, as indicated by export/ import records and other eel trade statistics, should also be promoted in future.

Implementation of the WFD will provide opportunities for acquisition of data on eel stocks and environmental conditions in inland and transitional eel habitats. The potential synergies between the WFD and eel monitoring programmes, from catchment to international levels, needs to be more widely recognised so that where practicable fish stock surveys are undertaken using protocols appropriate for eel stock assessments. Likewise, data management for eel monitoring purposes should be compatible with systems adopted at national and European levels for the WFD. Highlighting special requirements, such as the need to fully document fish stockings and anthropogenic obstacles to fish migration, as part of WFD national programmes could significantly increase the quality of eel population data that can potentially become available, at little extra cost, throughout much of EU.

The objectives for the monitoring are:

- evaluate progress towards the objectives of a stock recovery plan
- assess the compliance at sub-sampled (cf. WFD) catchments, national levels, EU levels and EU-Plus (Non-EU countries contributing to the eel stock) levels

When appropriate, at least the output of the monitoring on the different levels should be standardised among the nations.

The main geographic compartments to consider with regard to the different life stages are the Atlantic, the Mediterranean Coasts and the Baltic Sea. Large international river systems also need special attention.

The need of intercalibration exercises should also be considered.

5.2 Fisheries monitoring

The following items should be considered:

- catches (location/catchment, age- and size-structures)
- Effort
- CPUE

In regard to fisheries monitoring there is a need for catch data to cover the whole distribution area of the species. These data include commercial landings, angling and non-commercial catches, as well as discards.

There is a hierarchy of information needs relating to capture fisheries. At the International and National level the minimum data required is total catch for each life stage (glass eel, yellow eel and silver eel). At the catchment level and local levels more detailed data are necessary for management specifically data on catch, effort (CPUE) as well as size structure (and possibly age structure and sex ratio for the yellow and silver eel component), by gear type and location.

Ideally catch and effort data should be obtained using a logbook scheme where the fishermen records the weight of eel caught and the location on a daily basis. For passive gea, the number of instruments (hooks, traps, fyke net ends etc) and the number of nights deployed need to be recorded. For active gear such as trawls it is necessary to have some estimate of distance fished or time spent fishing. These data can then be summarised to provide monthly and/or annual reports as necessary. Improvements in the accuracy of the data can be obtained by the inclusion of observers on board the vessels or accompanying some of the fishermen, this also provides an opportunity to obtain supporting biological information. Information on landings can also be obtained from dealers and from custom and excise and does enable the accuracy of the returns to be assessed.

Catch returns should be compulsory for all types of licensed eel fisheries, and ideally be sent into the administrating body at monthly intervals through the season, as this helps to ensure compliance and reporting deadlines. However, in certain countries, considerable quantities of eel are caught quite legally by net fishermen who are not included in the licensing system. These fishermen either need to be included in the catch return system or their catch estimated using other methods such as postal or telephone surveys.

These data should be stored on a database to enable summary catch statistics to be produced and further analysis to be carried out at national and international levels. Biological data on the catch will also be needed and sampling will need to be stratified in relation to the size of the fishery, gear type and location.

5.3 Stock monitoring

The following should be considered:

- Recruitment
  - Natural *vs.* restocking
- Yellow eel
  - As recruits
  - Abundance, age, size, growth, mortality
- Silver eel escapement
  - Contaminants, pathogens

5.3.1 Recruitment

The recruitment of young eels to Europe is divided into two components, one being the oceanic part with glass eels at the coasts representing the spawning success and the other is the recruitment of larger eels to the yellow eel stock and to the exploited part of the stock, i.e. into catchments. The relationships between these two components are not known in any detail but density dependent processes are probably involved.

Recruitment needs to continue to be monitored according to the scheme outlined in the Final Report from the EU Concerted Action on Glass Eel Monitoring (Dekker 2002). In short, about 20 indices are derived from various sources of experimental and standardised sampling (like Den Oever, Netherlands), catches of ascending glass eels in eel passes (e.g. River Viskan, Sweden) or from fisheries data (e.g. Loire, France). Data representing true glass eels and later stages of the same age class are preferred. However, in some countries the only available data concerns older and mixed year classes. Such series could also be used as indices but should be dealt with separately (see 2.1 above). The network of existing sites from where recruitment series derives has considerable gaps in coverage which need to be filled by new, additional sites.

Data series from eel passes should preferably cover the whole season as the upstream migration varies between years due to water temperatures, flow etc. For similar reasons, fishery dependent data has to cover a considerable large part of the whole season

As restocking is a common practise and might become an important tool in a recovery plan, it is of outmost importance to monitor and keep good records on stocked numbers and weight. Additional data on where they are stocked (at least at a catchment level, but preferable referring to water body), their origin and life stage are also required.

5.3.2 Yellow eel

Yellow eel stocks are to be monitored as recruits to distant parts within the eel's distribution area and to freshwater (e.g. as in the Baltic Basin).

Monitoring yellow eel stocks in the more traditional way includes sampling from the stock to achieve estimates of their abundance (CPUE), size- and age distributions. There are several methods to adopt. Depending on the size structure of the stock and kind of habitat, methods such as electro-fishing, fyke netting, long lining, trawling etc. could be used. All methods are more or less selective, so the results have to be corrected for that. It is important that the samples are taken from non-graded catches. Large rivers might pose sampling problem, being too large for electro-fishing and to swift for e.g. fyke-netting and trawling.

Coastal areas, e.g. as in the Baltic Sea are complex systems with very long shore lines and gradients in salinities, water depths, productivity etc., making representative sampling difficult to perform. One approach to be further investigated is sampling with e.g. fyke nets along a number of transects from the inner parts of an archipelago to outer areas down to a certain water depth.

5.3.3 Silver eel escapement

The silver eels leaving Europe for the presumptive spawning area in the Sargasso Sea might be the most difficult part of eel's life to monitor. Silver eels are often descending rivers when sampling is difficult to perform due to high velocities, low temperatures and large amounts as debris are clogging the fishing gears.

Due to this and other reasons, estimates of total numbers of silver eel escapees are often hard or impossible to achieve and we have instead to relay on measurements of CPUE and other indices. In some cases, mark-recapture studies could help when correlating an index to the true values of silver eel escapement. In cases when such data all are not available, the yellow eel stock may be used as a proxy.

The biological sampling should include size, sex and age determination. Samples for that could be obtained from any more substantial fishery in a catchment according to some stratified sampling scheme. In catchments and areas without a fishery for silver eels samples might be taken from monitoring stations set up using some appropriate technique as fixed traps (pound nets) in standing waters or fishing weirs and eel boxes (Wolf-traps) in rivers (but see above on difficulties).

The extent and importance of silver eel escapement from some areas as the eastern parts of the Mediterranean Sea (e.g. Greece, Turkey and Egypt) is virtually unknown. Therefore it is important to have a good coverage all over the distribution area of the European eel.

An approach to representatively monitor the three major life stages in the European eel requires a full coverage of the main distribution area of the species. Details concerning sampling strategies with respect to spatial and temporal coverage and intensities are not yet formulated and requires a thorough analysis taking into account what the appropriate models require.

5.3.4 Contaminants and pathogens

Eels are as long-living, slow-growing and semelparous fish susceptible to a variety of persistent organic pollutants such as PCB, DDT, dioxins etc. They are also hosts of a large variety of parasites and other pathogens. They might all influence and decrease both the survival (quantity) and the quality of silver eels that supports the spawning stock, i.e. they are probably involved in the dimensioning of the effective population size.

Although we do not yet know the importance and relationships between these factors and the effective population size, we have to monitor and to investigate the importance of some of these factors and the quality of silver eels.

5.4 Habitat monitoring

Monitoring the habitat of the eel should preferably be done by making use as much as possible of the habitat monitoring in the WFD (2003).

The WFD covers all waters including inland waters (a.o. surface water) and transitional and coastal waters up to one sea mile (and for the chemical status also territorial waters which may extend to 12 sea miles) from the territorial baseline of a Member State independent of the size and the characteristics.

This totality of waters is, for the purpose of the implementation of the Directive, attributed to geographical or administrative units, in particular the river basin, the river basin district, and the “water body”. All water bodies are classified to Rivers, Lakes, Transitional Waters and Coastal Waters and these four elements all are included in river basins.

National authorities are responsible for reporting to the EU.

Rivers with catchment areas greater than 10 km^2 and lakes greater than 0.5 km^2 in surface area are water bodies that fall under the requirements of the Directive and might need to be included within the water status assessment and monitoring.

The Directive requires that sufficient surface water bodies are monitored in surveillance programme to provide an assessment of the overall surface water status within each catchment and sub-catchment within the river basin district. Operational monitoring is to establish the status of those water bodies identified as being at risk of failing their environmental objectives, and to assess any changes in their status from the programmes of measures. Operational monitoring programmes must use parameters indicative of the quality element or elements most sensitive to the pressure or pressures to which the body or group of bodies is subject.

Surveillance monitoring has to be undertaken for at least a period of one year during the period of a River Basin Management Plan (RBMP). The deadline for the first RBMP is 22 December 2009. The monitoring programmes must start by 22 December 2006. The first results will be needed for the first draft RBMP to be published at the end of 2008, and then for the finalised RBMPs at the end of 2009. These plans must include status maps.

Although the quality element (QE) "Fish" is only mentioned in Rivers, Lakes and Transitional Waters, the habitat in general sense will also be monitored in coastal waters. As coastal waters are important habitats for eel, the WFD habitat monitoring results can be used in the habitat models for the eel.

The WFD applies for all EU-countries. The habitat will be sampled according to the WFD in more or less the whole geographical distribution area of the eel and in both coastal and in inland waters and in rivers as well as in lakes. Note, however, that non-EU countries in the Southern and Eastern Mediterranean and Norway are not involved in the WFD.

Data collected with regard to the habitat will not only be the quality parameters, but will also be surface areas of habitat and hydromorphological pressures such as weirs (and hydropower stations?). Therefore, if available, the data can relatively easily be aggregated to different management levels: the Baltic, the Mediterranean, the Atlantic Coast, large international rivers, catchments, national and European-plus levels.

5.5 Use of WFD habitat data for the eel

The extent to which the WFD data are sufficient for the use for management purposes of the eel depends on the input variables of the habitat models for the eel. As has been discussed elsewhere, these input variables are not known yet. One may conclude at this stage that the WFD habitat data are likely to provide sufficient data, but this has to be checked.

There is still some uncertainty about the exact habitat parameters sampled by the member states and how they will do their samplings, because they may decide about that by themselves to some extend. This is another reason why it is not possible at this moment to compare the habitat data generated by the WFD with the habitat data needed as input for the habitat models. Additional inquiries are needed to get a clear picture of the actual practise of habitat sampling foreseen in the EU member states (has any MS made plans, yet?).

The use of the WFD data for eel management is not stipulated in the WFD. It is important that these WFD data will become available for drawing up the models and ultimately for the management of the eel on a catchment and higher scale by using these models by the appropriate authorities.

It is therefore recommended that the results of the monitoring programmes on habitat indicated in the WFD are made available for use by scientists and managers involved with recovery plans for the eel. Eel specific extensions of the WFD should be considered in order to increase efficiency.

5.6 Fisheries Data Collection Programme

The following items should be considered:

- Precision and accuracy
- Sampling strategies (including also restocking)

    - Subsampling (stratified), catchment and national levels, exploited or not Compliance is required on the national basis, not always on a catchment basis.
    - To evaluate to which extent data from WFD enables compliance to be assessed
- Pilot projects
- Database management
- Communication (feedback to the stakeholders and authorities)
- Financial resources and costs
- Non EU data sources (if available and how to include them)

The fundamental objective is to be able to report on progress of the stock recovery plan, in essence being able to estimate compliance with the target of silver eel escapement of 50% of that under pristine conditions, for the stock as a whole and the trend over time. The main issue being that the stock is widely dispersed over numerous countries and water bodies. It is very unlikely that all water bodies would be assessed for compliance and as such compliance will need to be determined from a subsample of water bodies. Subsampling might be carried out on the following basis:

Fished / unfished waters

Size of river

Habitat: lentic / lotic / transitional / coastal waters

Distance from upstream from the tidal limit

For glass eel there are at the moment circa 20 locations where recruitment is monitored annually. These monitoring programmes need to be maintained as they will provide the first indications of the effectiveness of the management actions taken towards rebuilding the stock.

In a few instances, it will be possible to estimate spawning escapement directly or through mark recapture programmes, but in the vast majority of cases this will not be possible. Silver eel escapement will therefore have to be derived from the yellow eel stock. Though the methods for catching yellow eel are well established, only electric fishing can provide robust estimates of abundance. However, electric fishing is limited to shallow wadeable areas of stream and thus many areas of the catchment (lakes, deep (>1 m) riverine stretches and transitional waters) will be underrepresented. It is therefore suggested a pilot(s) study be undertaken to investigate how best quantify the standing stock of eel in a catchment

The WFDoffers a potential source of data and it is imperative that the data available be assessed with that required for eel in order to ensure efficiency savings. Additional monitoring programs will then be required to assess the shortfall in data requirements, for example an eel-specific programme is likely to be needed to obtain the necessary biological data. It is important to ensure that databases are compatible allowing efficient integration of different data sets, for example environmental data with abundance data.

One of the main concerns is that the data obtained as part of the WFD will not be of sufficient accuracy or biologically detailed, as the surveys will target all species and thus eel will be underrepresented. Figure 5.6.1 shows that the density of eel assessed, at the same site, was substantially lower when all species were targeted as opposed to when only eel was the target species. In fact what appears to be the case is that there is an upper limit of eel recorded at a site irrespective of the actual density of eel.

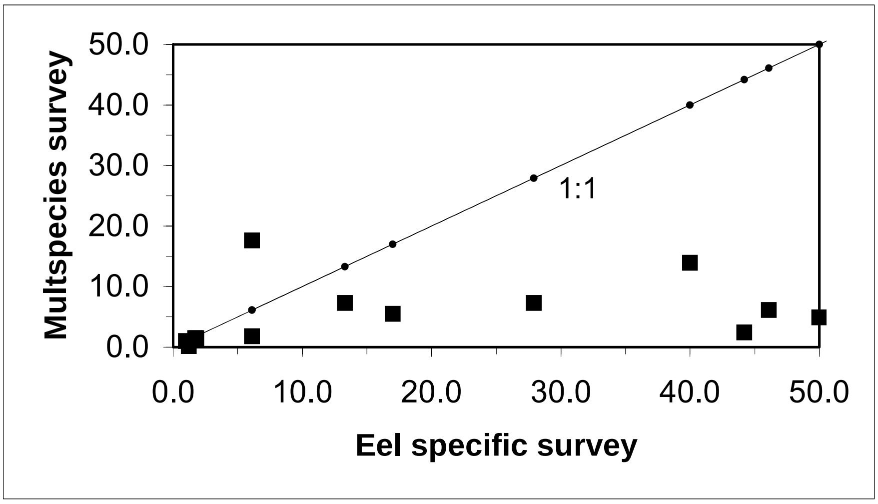

Figure 5.6.1. Comparison of eel density (100m)[2] in multispecies surveys and in eel specific surveys (Knights *et al*, 2001).

5.7 Feedback of results to the management

The following items should be considered:

- Which management (catchment, local, regional, national, EU….)?
- What to feed back? ((analysis), status of fish, fisheries and habitat, advice)
- Periodicity (annual, with a five year review?)
- How are we progressing towards our stock recovery objectives?

6 Conclusions and Recommendations

6.1 Conclusions from this report

Review of the available information on the status of the stock and fisheries of the European eel supports the view that the population as a whole has declined in most of the distribution area, that the stock is outside safe biological limits and that current fisheries are not sustainable. Recruitment is at a historical minimum and most recent observations indicate the decline continues in many areas. There is some evidence that depensation in the reproductive phase might be involved, triggering a new and heightened level of precautionary advice. Under this situation, the advice is to restore SSB above levels at which depensation is expected not to occur.

Evidence has been given in earlier reports that anthropogenic factors (e.g. exploitation, habitat loss, contamination and transfer of parasites and diseases) as well as natural processes (e.g. climate change, predation) have contributed to the decline. Measures aimed at recovery of the stock are well known and may include control of exploitation, restocking of recruits and restoration of habitats (including access to and from).

The continental population extends throughout Europe and northern Africa and fisheries are scattered over many large and small water bodies, both marine and fresh water. Management at the local level has not adequately addressed the global decline of the stock, and no co-ordinated stock-wide management framework has been set up. The continuation of the decline demonstrated by most recent data makes the development and implementation of an international stock recovery plan a necessity.

6.2 Strengthening the knowledge base

The information in this report constitutes a further step in an ongoing process of documenting eel stock status and fisheries and developing a methodology for giving scientific advice on management, specifically for eel. To this end, a line of thought has been generated in previous reports (ICES, 2000; 2002), and an inventory of ultimately required knowledge assembled (Moriarty and Dekker 1997; ICES, 2000; 2001). Given the depleted state of the stock, urgent management actions are required, as emphasized in the recent Communication from the Commission (COM 2003, 573 final). Past meetings of the working group have focused on compilation and completion of the data base for assessment of the status of the stock and subsequent management advice; the current meeting explored the monitoring and assessment framework required for sustainable management of the stock and fisheries.

A recurring theme in previous reports has been the inadequacy of the available data base for analytical assessment of the stock and impacts on it. As indicated in Section 5, improvement of the data base will undoubtedly be required, by judicious extension of field programmes (e.g. Fisheries Data Collection Programme FDCP) as well as by incorporation of data resulting from ongoing programmes (e.g. Water Framework Directive WFD). Monitoring of recruitment, stocks, fisheries and escapement should be at least sustained at current levels. It is unlikely that substantially more and better data, although mandatory for sustainable management of the eel, will become available in short term. Current obligations for monitoring (Fisheries Data Collection Programme and the monitoring under the Water Framework Directive) are not yet adequate for assessment and sustainable management of the eel stock, both in contents and in envisaged time frame. The Water Framework Directive sets a time horizon of several years, while the Fisheries Data Collection Programme already includes an obligation, but not a standing practice of recording landings and monitoring stock and fisheries. Further completion of the conceptual framework, development of assessment and modelling tools and establishment of an international data clearinghouse, overall stock assessment and post-evaluation system must therefore proceed on the basis of the already available, albeit incomplete information.

The global objectives of stock protection and rebuilding must be translated into actual management targets at the national and regional level, considering the three exploited life stages, as well as habitat restoration. It is highly unlikely that a full analytical assessment of the status of a local stock and the anthropogenic impacts in relation to these targets can be implemented in all the waters in Europe where eels are found. Pragmatic approaches and the inclusion of models are required, an initiative that is currently under construction in several research institutes in Europe. Coordination, standardisation and comprehensiveness will be required, to achieve a flexible, cost-effective, adequate, and mutually accepted approach throughout the distribution area. These developments would benefit from, and be accelerated by, provisional application in test case projects. The existing information available for a small selection of catchments is adequate to allow for a pilot implementation. Organisation of a workshop is recommended, in which modelling approaches across Europe are compared, a comprehensive and common approach is selected, and applied to real data available for a judicious choice of water bodies.

6.3 Recommendations

The EIFAC/ICES Working Group on Eels at its 2004 session in Galway (Ireland) reiterates its recommendation first made in 1999 that:

- An international recovery plan for the European eel stock be developed for the whole stock on an urgent basis and that exploitation and other anthropogenic impacts on production/escapement of silver eels be reduced to as close to zero as possible, until such a plan is agreed upon and implemented;

And now recommends that:

- Further development of methodologies to assess stock status, set conservation and management targets, assess compliance with these targets and post-evaluate the effect of appropriate management actions is organised in a work programme, in which existing research efforts are integrated and applied to test cases of water bodies, for which data are readily available.
- The monitoring activities required by the Fisheries Data Collection Programme are implemented for the eel stock and fisheries immediately, and that the adequacy of the monitoring programmes, is reconsidered specifically for eel.
- Under the implementation of the Water Framework Directive, eel specific extensions should be considered/evaluated.
- The desirability of restocking programmes as an additional stock protection measure is given urgent consideration, given the current extremely low recruitment of glass eels over much of their range, and the possibly limited time frame (ca. 5 years) available for enhancement of future silver eel escapement to levels at which depensation is unlikely to occur. In this consideration, the inability to quantify the risks involved must be borne in mind.

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