JOINT EIFAAC/ICES/GFCM WGEEL REPORT 2015

Analysis of Recruitment Trend

1 October 2015

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International Council for
the Exploration of the Sea

Conseil International pour
l'Exploration de la Mer

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Recommended format for purposes of citation:

ICES. 2015. Analysis of Recruitment Trend, 1 October 2015.
ICES CM 2015/ACOM:18. 18 pp.

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Analysis of recruitment trend

1 Data and trends in glass and yellow eel recruitment indices

This chapter addresses the latest trends in glass and yellow eel indices and produces the first draft of the ICES eel advice.

1.1 Recruitment

1.1.1 Time–series available

The recruitment time-series data are derived from fishery-dependent sources (i.e. catch records) and also from fishery-independent surveys across much of the geographic range of European eel (Figure 1.1). The stages are categorized as glass eel (gls.), mixture of glass eel and young yellow eel (gls.+ylw.) and older yellow eel (ylw.) recruiting to continental habitats (Dekker, 2002).

Figure 1.1. Location of the recruitment monitoring sites in Europe, white circle = glass eel, blue circle = glass eel and young yellow eels, yellow square=yellow eel series.

The glass eel recruitment time-series have also been classified according to two areas: 'continental North Sea' and 'Elsewhere Europe', as it cannot be ruled out that recruitment to the two areas has different trends (ICES, 2010). The glass eel recruitment series are either comprised of only glass eel or of a mixture of glass eel and young yellow eel. Yellow eel series are predominantly made of young yellow eel, or of yellow eel that might be several years old (in the Baltic).

The WGEEL has collated information on recruitment from 51 time-series. Some time-series date back to the beginning of 20th century (yellow eel, Gota Älv, Sweden) or 1920 (glass eel, Loire, France).

- 36 time-series were updated to 2015 (26 for glass eel and ten for yellow eel Table 1.3 in Appendix).
- Five time-series (three for glass eel and two for yellow eel) were updated to 2014 only (Table 1.4 in Appendix).
- Among the time-series based on trap indices, some have reported preliminary data for 2015 as the season is not yet finished (Lagan (SW), Kavlinge-

an (SW), Göta Älv (SW), Motalä Stom (SW), Parteen(IR), Bann (GB), Frémur (FR), Bresle (FR)), while others have not yet reported (Guden Å (DK), Harte (DK)). Therefore, the indices given for 2015 must be considered as provisional especially those for the yellow eel.

- Ten time-series have been stopped (ten for glass eel and none for yellow eel, Table 1.5 in Appendix). They stopped reporting either because of a lack of recruits in the case of the fishery-based surveys (Ems in Germany, stopped in 2001; Vidaa in Denmark, stopped in 1990), a lack of financial support (the Tiber in Italy, 2006) or the introduction of quota from 2008 to 2011 that has disrupted the five fishery-based French time-series. Note the French Vilaine time-series could be used again in 2015 because the glass eel fishery never achieved its quota.

The number of glass eel and glass eel + young yellow eel time-series available has declined from a peak of 33 in 2008. The maximum number of older yellow eel time-series has increased to 12 in 2014 (Figure 1.2).
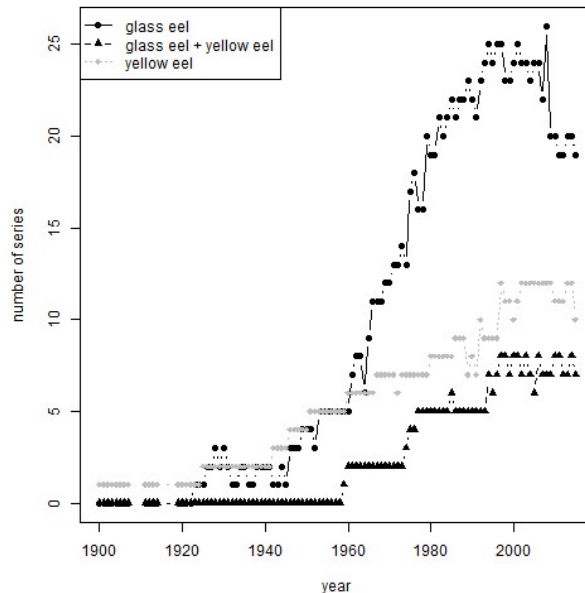
Figure 1.2. Trends in number of glass (black circle), glass+young yellow eel (grey triangle) and older yellow eel (black triangle) time-series giving a report in any specific year.

1.1.2 Raw data

Calculation of the geometric mean of all time-series is given in (Figures 1.3 and 1.4). [1].

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[1] This figure is given as it consistent with the trend provided by WGEEL from 2002 to 2006. The scaling is performed on the 1979–1994 average of each time-series, and seven time-series without data during that period are excluded from the analysis. The time-series left out are: Bres, Fre, Inag, Klit, Maig, Nors, Sle.
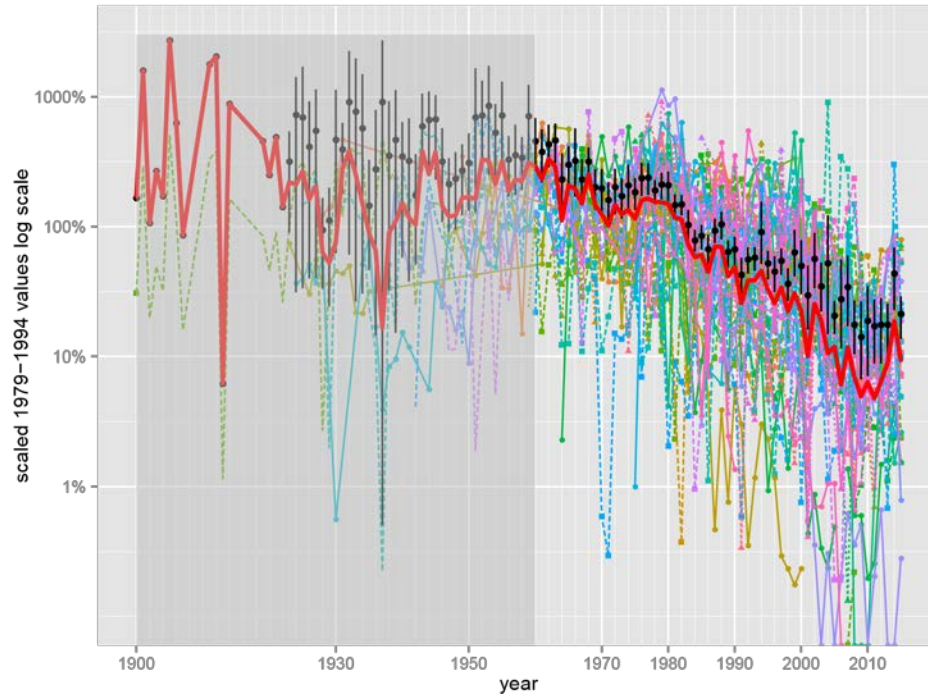
Figure 1.3. Time-series of glass eel and yellow eel recruitment in European rivers with time-series having data for the 1979–1994 period (44 sites). Each time-series has been scaled to its 1979–1994 average. Note the logarithmic scale on the y-axis. The mean values and their bootstrap confidence interval (95%) are represented as black dots and bars. Geometric means are presented in red.

Separate trends for both glass eel and yellow eel time-series were introduced by the WGEEL in 2006 (Figure 1.4).
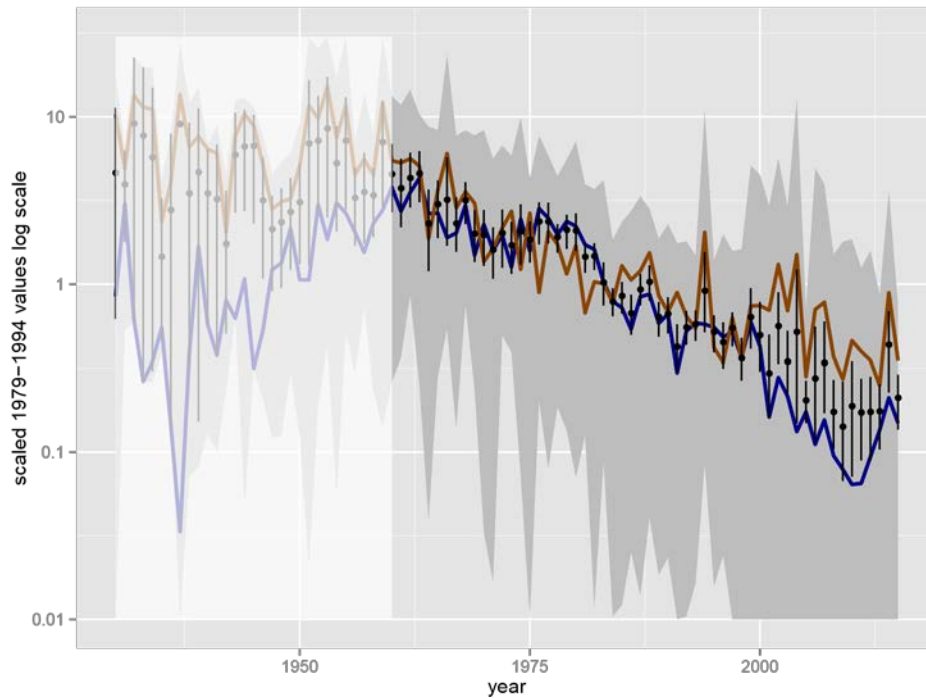
1.1.3 Trends in recruitment

Figure 1.4. Time-series of glass eel and yellow eel recruitment in Europe with 44 time-series out of the 51 available to the working group. Each time-series has been scaled to its 1979–1994 average. The mean values of combined yellow and glass eel time-series and their bootstrap confidence interval (95%) are represented as black dots and bars. The brown line represents the mean value for yellow eel, the blue line represents the mean value for glass eel time-series. The range of these time-series is indicated by a grey shade. Note that individual time-series from Figure 1.3 were removed to make the mean value more clear. Note also the logarithmic scale on the y-axis.

1.1.3.1 GLM based trend

The WGEEL recruitment index is a reconstructed prediction using a GLM (General-ised Linear Model) with gamma distribution and a log link: *glass eel ~ year : area + site*, where *glass eel* is individual glass eel time-series, *site* is the site monitored for recruitment and area is either the continental North Sea or Elsewhere Europe. In the case of yellow eel time-series, only one estimate is provided: *yellow eel ~ year + site*.

The trend is reconstructed using the predictions from 1949 for 39 glass eel time-series and 12 yellow eel time-series. Some zero values have been excluded from the GLM analysis: 12 for the glass eel model and one for the yellow eel model.

The reconstructed values are then aggregated using geometric means of the two ref-erence area (Elsewhere Europe EE, and North Sea NS). The predictions are given in reference to the geometric mean of the 1960–1979 period. Note that the shift from arithmetic to geometric means was done this year as the recruitment is usually as-sumed to be lognormally distributed (Drouineau *et al.*, 2016).

After high levels in the late 1970s, there has been a rapid decreasing trend for three decades to a minimum in 2009 (Figures 1.5–1.6).
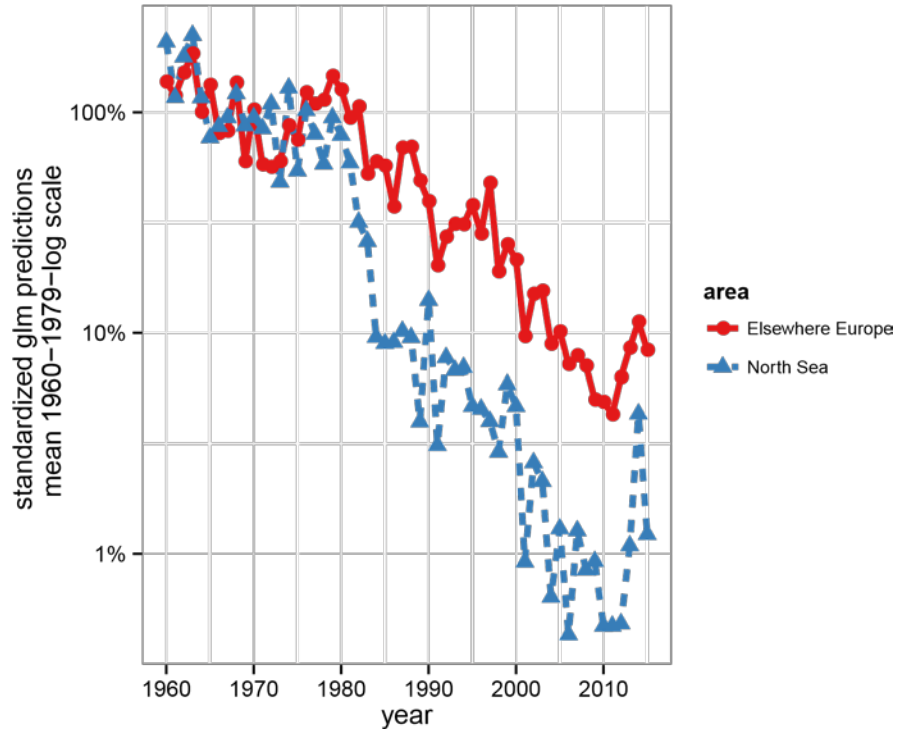
Figure 1.5. WGEEL recruitment index: geometric mean of estimated (GLM) glass eel recruitment for the continental North Sea and Elsewhere Europe series updated to 2015. The GLM (*recruit ~ area* : *year* + *site*) was fitted on 39 time-series comprising either pure glass eel or a mixture of glass eels and yellow eels and scaled to the 1960–1979 average. No time-series are available for glass eel in the Baltic area. Note the logarithmic scale on the y-axis.

Both WGEEL recruitment indices for 2015 are lower than 2014, but modelling a breakpoint around the minima of 2011 still gives significant results when using the lower value from 2015 ($p=4e-04$ Elsewhere Europe and $p=2e-04$ North Sea ICES SGIPEE(2011)). The 2015 level with respect to 1960–1979 averages is 1.2% for the North Sea and 8.4% elsewhere in the distribution area (Tables 1.1 and 1.2).
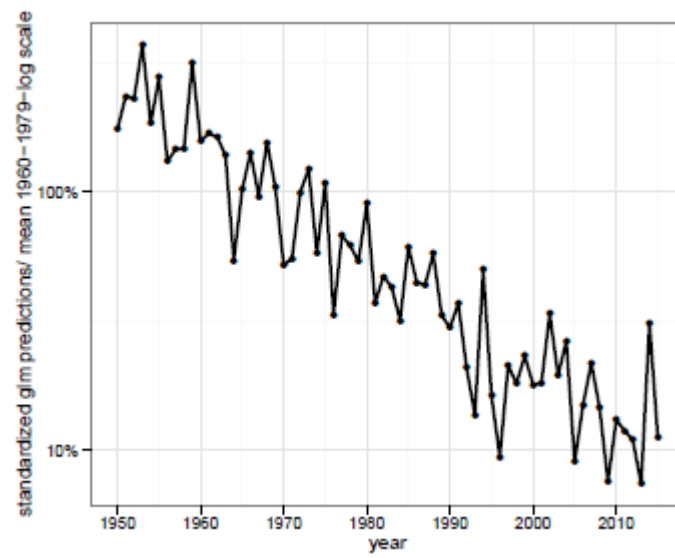
Figure 1.6. Geometric mean of estimated (GLM) yellow eel recruitment and smoothed trends for Europe updated to 2015. The GLM (*recruit ~ year + site*) was fitted to 12 yellow eel time-series and scaled to the 1960–1979 average. Note the logarithmic scale on the y-axis.

Table 1.1. GLM *glass eel ~ year* : *area + site* geometric means of predicted values for 39 glass eel series, values given in percentage of the 1960–1979 period.

|	1960		1970		1980		1990		2000		2010	
	EE	NS	EE	NS	EE	NS	EE	NS	EE	NS	EE	NS
0	138	209	103	95	127	79	40	14	21.4	4.7	4.9	0.5
1	119	117	58	84	95	59	20	3	9.7	0.9	4.3	0.5
2	152	178	57	109	106	32	27	8	15.0	2.6	6.3	0.5
3	185	224	60	48	53	26	31	7	15.5	2.1	8.6	1.1
4	100	117	87	129	60	10	31	7	8.9	0.6	11.2	4.3
5	133	77	75	54	57	9	38	5	10.1	1.3	8.4	1.2
6	81	86	123	102	37	9	28	5	7.2	0.4		
7	83	95	109	80	69	10	48	4	7.9	1.3		
8	136	122	114	58	70	10	19	3	7.1	0.8		
9	60	87	146	95	49	4	25	6	5.0	0.9		

Table 1.2. GLM *yellow eel ~ year + site* geometric means of predicted values for 12 yellow eel series, values given in percentage of the 1960–1979 period.

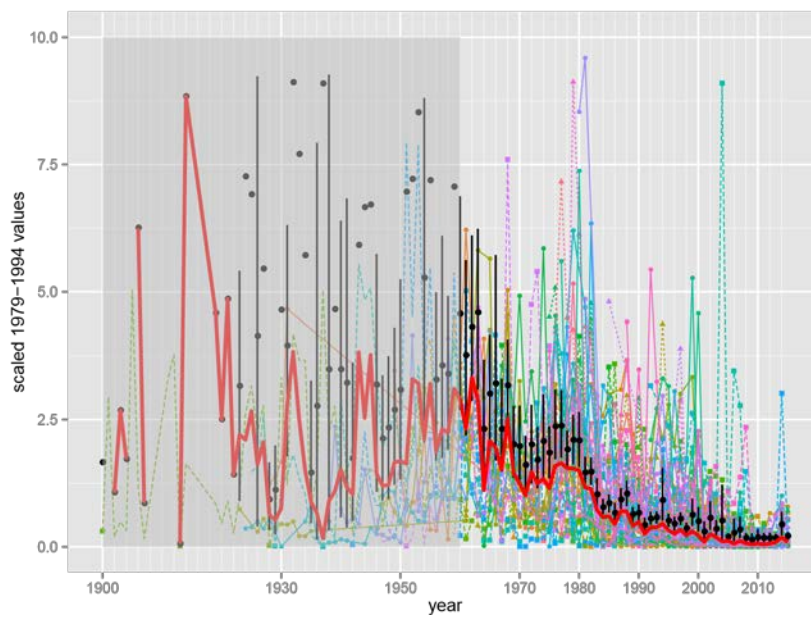|	1950	1960	1970	1980	1990	2000	2010
0	175	158	52	90	30	18	13
1	236	168	56	37	37	18	12
2	230	164	100	47	21	34	11
3	372	139	123	43	14	20	7
4	184	55	58	32	50	26	31
5	278	102	109	62	16	9	11
6	132	142	34	45	9	15	
7	146	97	68	44	21	22	
8	148	156	62	58	18	15	
9	316	104	54	33	23	8	

Appendix

Figure 1.7. Same as Figure 1.3 but without log scale.
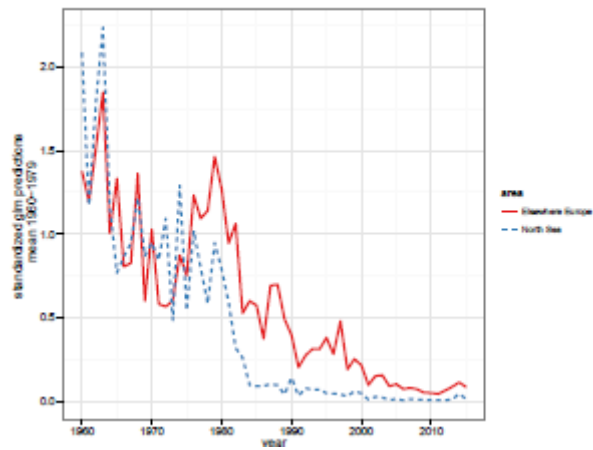
Figure 1.8. Same as Figure 1.5 but without a log scale.

Figure 1.9. Same graph as Figure 1.6 but without a log scale.

Table 1.3. Series updated to 2015.

CODE	NAME	COUNTRY	AREA	STAGE
Kavl	Kavlingeän trapping all¨	Sweden	Baltic	ylw.
Dala	Dalalven trapping all¨	Sweden	Baltic	ylw.
SeHM	Severn HMRC commercial catch	UK	British Isle	gls.
MiSp	Minho Spanish part commercial catch	Spain	Atlantic Ocean	gls.
Bres	Bresle	France	Atlantic Ocean	gls. + ylw.
Vil	Vilaine Arzal trapping all	France	Atlantic Ocean	gls.
ShaA	Shannon Ardnacrusha trapping all	Ireland	British Isle	gls. + ylw.
Nalo	Nalon Estuary commercial catch	Spain	Atlantic Ocean	gls.
Feal	River Feale	Ireland	Atlantic Ocean	gls. + ylw.
MiPo	Minho Portugese part commercial catch	Portugal	Atlantic Ocean	gls.
GiSc	Gironde scientific estimate	France	Atlantic Ocean	gls.
Ebro	Ebro delta lagoons	Spain	Mediterannean Sea	gls.
Morr	Morrumsän trapping all¨	Sweden	Baltic	ylw.
Mota	Motala Strom trapping all¨	Sweden	Baltic	ylw.
ShaP	Shannon Parteen trapping partial	Ireland	British Isle	ylw.
Bann	Bann Coleraine trapping partial	Northern Ireland	British Isle	gls. + ylw.
Maig	River Maigue	Ireland	Atlantic Ocean	gls.
Inag	River Inagh	Ireland	Atlantic Ocean	gls. + ylw.
Erne	Erne Ballyshannon trapping all	Ireland	British Isle	gls. + ylw.
Ring	Ringhals scientific survey	Sweden	North Sea	gls.
Stel	Stellendam scientific estimate	Netherlands	North Sea	gls.
Yser	Ijzer Nieuwpoort scientific estimate	Belgium	North Sea	gls.
YFS2	IYFS2 scientific estimate	Sweden	North Sea	gls.
Imsa	Imsa Near Sandnes trapping all	Norway	North Sea	gls.
Laga	Lagan trapping all	Sweden	North Sea	ylw.
Fre	Frémur	France	North Sea	ylw.
RhDO	Rhine DenOever scientific estimate	Netherlands	North Sea	gls.
RhIj	Rhine IJmuiden scientific estimate	Netherlands	North Sea	gls.
Ronn	Ronne Å trapping all	Sweden	North Sea	ylw.
Katw	Katwijk scientific estimate	Netherlands	North Sea	gls.
Meus	Meuse Lixhe dam trapping partial	Belgium	North Sea	ylw.
Gota	Gota Älv trapping all¨	Sweden	North Sea	ylw.
Visk	Viskan Sluices trapping all	Sweden	North Sea	gls. + ylw.
Sle	Slette A	Denmark	North Sea	gls. + ylw.
Klit	Klitmoeller A	Denmark	North Sea	gls. + ylw.
Nors	Nors A	Denmark	North Sea	gls. + ylw.

Table 1.4. Series updated to 2014.

CODE	NAME	COUNTRY	AREA	STAGE
Albu	Albufera de Valencia commercial Spain catch		Mediterannean Sea	gls.
Hart	Harte trapping all Denmark		Baltic	ylw.
AlCP	Albufera de Valencia commercial Spain cpue		Mediterannean Sea	gls.
Gude	Guden Å Tange trapping all Denmark		North Sea	ylw.
Lauw	Lauwersoog scientific estimate Netherlands		North Sea	gls.

Table 1.5. Series stopped or not updated to 2014.

Code	Name	Country	Area	Stage	Last year
YFS1	IYFS scientific estimate	Sweden	North Sea	gls.	1989
Vida	Vidaa Højer sluice commercial catch	Denmark	North Sea	gls.	1990
Ems	Ems Herbrum commercial catch	Germany	North Sea	gls.	2001
Tibe	Tiber Fiumara Grande commercial catch	Italy	Mediterannean Sea	gls.	2006
AdCP	Adour Estuary (cpue) commercial cpue	France	Atlantic Ocean	gls.	2008
AdTC	Adour Estuary (catch) commercial catch	France	Atlantic Ocean	gls.	2008
GiCP	Gironde Estuary (cpue) commercial cpue	France	Atlantic Ocean	gls.	2008
GiTC	Gironde Estuary (catch) commercial catch	France	Atlantic Ocean	gls.	2008
Loi	Loire Estuary commercial catch	France	Atlantic Ocean	gls.	2008
SevN	Sèvres Niortaise Estuary commercial cpue	France	Atlantic Ocean	gls.	2008

Table 1.6. Short description of the recruitment sites.

CODE	AREA	MIN	MAX	N+	N−	LIFE STAGE	RIVER	SAMPLING TYPE	UNIT
Imsa	NS	1975	2015	41	1	gls.	Imsa	trap	Number
YFS2	NS	1991	2015	25	0	gls.	.	sci. surv.	Index
Ring	NS	1981	2015	35	0	gls.	Kattegat-Skagerrak	sci. surv.	Index
Visk	NS	1972	2015	44	0	gls.+ylw.	Viskan	trap	Kg
Sle	NS	2008	2015	8	0	gls.+ylw.	Slette A	sci. surv.	eel/m2
Klit	NS	2008	2015	8	0	gls.+ylw.	Klitmoeller A	sci. surv.	eel/m2
Nors	NS	2008	2015	8	0	gls.+ylw.	Nors A	sci. surv.	eel/m2
Bann	EE	1960	2015	56	0	gls.+ylw.	Bann	trap	Kg
Erne	EE	1959	2015	57	2	gls.+ylw.	Erne	trap	Kg
Feal	EE	1985	2015	31	14	gls.+ylw.	Feale	trap	Kg
Maig	EE	1994	2015	22	4	gls.	Maigue	trap	Kg
Inag	EE	1996	2015	20	4	gls.+ylw.	Inagh	trap	Kg
ShaA	EE	1977	2015	39	0	gls.+ylw.	Shannon	trap	Kg
SeHM	EE	1979	2015	37	4	gls.	Severn	com. catch	t
Vida	NS	1971	1990	20	0	gls.	Vidaa	com. catch	Kg
Ems	NS	1946	2001	56	0	gls.	Ems	com. catch	Kg
Lauw	NS	1976	2015	40	4	gls.	.	sci. surv.	nb/h
RhDO	NS	1938	2015	78	1	gls.	Rhine	sci. surv.	Index
RhIj	NS	1969	2015	47	5	gls.	Rhine	sci. surv.	Index
Katw	NS	1977	2015	39	5	gls.	.	sci. surv.	Index

Table 1.7. Short description of the recruitment sites (continued).

CODE	AREA	MIN	MAX	N+	N−	LIFE STAGE	RIVER	SAMPLING TYPE	UNIT
Stel	NS	1971	2015	45	0	gls.	.	sci. surv.	Index
Yser	NS	1964	2015	52	1	gls.	Ijzer	sci. surv.	Kg
Bres	EE	1994	2015	22	0	gls.+ylw.	Bresle	trap	Number
Vil	EE	1971	2015	45	3	gls.	Vilaine	trap	t
Loi	EE	1924	2008	85	6	gls.	Loire	com. catch	Kg
SevN	EE	1962	2008	47	25	gls.	Sèvres Niortaise	com. cpue	cpue
GiSc	EE	1992	2015	24	1	gls.	Gironde	sci. surv.	Index
GiTC	EE	1923	2008	86	28	gls.	Gironde	com. catch	t
GiCP	EE	1961	2008	48	1	gls.	Gironde	com. cpue	cpue
AdTC	EE	1986	2008	23	0	gls.	Adour	com. catch	t
AdCP	EE	1928	2008	81	40	gls.	Adour	com. cpue	cpue
Nalo	EE	1953	2015	63	0	gls.	Nalon	com. catch	Kg
MiSp	EE	1975	2015	41	0	gls.	Minho	com. catch	Kg
MiPo	EE	1975	2015	41	0	gls.	Minho	com. catch	Kg
Albu	EE	1949	2014	66	5	gls.	Albufera lagoon	com. catch	Kg
Ebro	EE	1966	2015	50	3	gls.	Ebro delta lagoons	com. catch	Kg
AlCP	EE	1982	2014	33	5	gls.	Albufera lagoon	com. cpue	cpue
Tibe	EE	1975	2006	32	0	gls.	Tiber	com. catch	t
YFS1	NS	1975	1989	15	0	gls.	.	sci. surv.	Index

Table 1.8: Short description of the recruitment sites (continued-yellow eel series)

CODE	AREA	MIN	MAX	N+	N−	LIFE STAGE	RIVER	SAMPLING TYPE	UNIT
Dala	EE	1951	2015	65	3	ylw.	Dalalven	trap	Kg
Mota	EE	1942	2015	74	0	ylw.	Motala Strom	trap	Kg
Morr	EE	1960	2015	56	0	ylw.	Morrumsän	trap	Kg
Kavl	EE	1992	2015	24	0	ylw.	Kavlingeän	trap	Kg
Ronn	NS	1946	2015	70	9	ylw.	Ronne Å	trap	Kg
Laga	NS	1925	2015	91	0	ylw.	Lagan	trap	Kg
Gota	NS	1900	2015	116	12	ylw.	Gota Älv	trap	Kg
ShaP	EE	1985	2015	31	0	ylw.	Shannon	trap	Kg
Gude	NS	1980	2014	35	1	ylw.	Guden Å	trap	Kg
Hart	EE	1967	2014	48	1	ylw.	Harte	trap	Kg
Meus	NS	1992	2015	24	3	ylw.	Meuse	trap	Kg
Fre	NS	1997	2015	19	0	ylw.	Frèmur	trap	Number