Report on the eel stock, fishery and other impacts in Denmark, 2018–2019

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Reporting Period: This report was completed in August 2019 and contains data up to 2018 and some provisional data for 2019.

1 Summary of national and international stock status indicators

1.1 Escapement, biomass and mortality rates

For 2018 there are no new data.

Year	EMU_code	Assessed Area (ha)	B_0 (kg)	B_{curr} (kg)	B_{best} (kg)	Bcurr/B_0 (%)	∑A	∑F	∑H
2017	Dk_inla	60.000	1.110.000	125.31	168.97	11.3	0.222	0.163	0.059
2018	Dk_inla	ND	ND	ND	ND	ND	ND	ND	ND

Dk_inla. Assessed area (ha) of inland waters. B_0 = the amount of silver eel biomass that would have existed if no anthropogenic influences had impacted the stock (kg); B_{curr} = the amount of silver eel biomass that currently escapes to the sea to spawn (in the assessment year) (kg); B_{best} = the amount of silver eel biomass that would have existed if no anthropogenic influences had impacted the current stock (kg); ∑F = mortality due to fishing, summed over the age groups in the stock (rate); ∑H = anthropogenic mortality excluding the fishery, summed over the age groups in the stock (rate); ∑A = all anthropogenic mortality summed over the age groups in the stock (rate).

1.2 Recruitment time-series

1.2.1 Yellow eel recruitment

The recruitment of young eels, to Danish freshwater, is monitored in pass traps at Harte Hydropower Station in river Kolding Å and at Tange Hydropower Station in river Guden Å. Both rivers empty into Kattegat on the east coast of Jutland. On the west coast of Jutland no passive trapping facilities are available. Here the recruitment is monitored in Vester Vedsted brook a small brook by the Wadden Sea. See also Section 9.1 for further information on glass eel monitoring by electrofishing.

In **Vester Vedsted brook** an annual population surveys is made by electrofishing four sections of the brook three times a year (further details in Pedersen, 2002).

At **Harte Hydropower Station** the condition for monitoring recruitment at the eel ladder trap has changed. As part of a river restoration project in River Kolding Å, the water supply to Harte Hydropower station has been reduced by 60% since spring/summer 2008. The effect of lower water supply at the trapping site is a decrease in recruitment to the trapping site reflected in the data. This is the second time a major change to the eel monitoring in River Kolding Å has taken place, since monitoring started in 1967. The first change was in 1991 where a trapping facility was terminated at the Stubdrup Weir. At that time a bypass stream was made at the Stubdrup weir allowing eels to bypass the weir without being trapped. This change is also reflected in the recruitment data (Table 1.2.1).

Due to repair work at Harte Hydropower station the water flow was reduced in 2015 during August and September, and a lower catch of ascending elvers was expected in 2015.

At **Tange Hydropower Station**. The local staff at the station is responsible for the daily maintenance of the el eel ladder trap and registration of data. The fishery in the reservoir lake Tange

has terminated and the trap has not been in operation since 2015 and no data are available during the last years.

Table 1.2.1. Recruitment data from Tange and Harte Hydropower Stations and Vester Vedsted brook. Mean density during the year and maximum density at any electrofishing occasion.

YEAR	TANGE	HARTE	VESTER VEDSTED BROOK		YEAR	TANGE	HARTE	VESTER VEDSTED BROOK		YEAR	TANGE	HARTE	VESTER VEDSTED BROOK	
			DENSITY EEL/M²					DENSITY EEL/M²					DENSITY EEL/M²	
Year	Kg	Kg	Mean	Max (season)	Year	Kg	Kg	Mean	Max (season)	Year	Kg	Kg	Mean	Max (season)
1967	-	500	-	-	1987	145	105	-	-	2006	123	7	0.3	0.7
1968	-	200	-	-	1988	252	253	-	-	2007	62	7	0.4	0.5
1969	-	175	-	-	1989	354	145	-	-	2008	131	0.9	0.2	0.2
1970	-	235	-	-	1990	367	101	-	-	2009	20	1.3	0.2	0.2
1971	-	59	-	-	1991	434	44	-	-	2010	14	5	0.2	0.4
1973	-	117	-	-	1992	53	40	-	-	2011	84.6	3.6	0.3	0.3
1974	-	212	-	-	1993	93	26	-	-	2012	-	4.1	0.1	0.2
1975	-	325	-	-	1994	312	35	-	-	2013	47	1.4	0.1	0.2
1976	-	91	-	-	1995	83	23	2.6	2.6	2014	36	3.0	0.1	0.1
1977	-	386	-	-	1996	56	6	4.6	6.8	2015	NA	1.3	0.2	0.2
1978	-	334	-	-	1997	390	9	0.7	1	2016	NA	2.4	0.3	0.3
1979	-	291	2.8	6.5	1998	29	18	0.3	0.4	2017	NA	0.9	0.14	0.3
1980	93	522	7	13	1999	346	15	0.4	0.5	2018	NA	0.7	0.47	0.59
1981	187	279	7.8	13	2000	88	18	0.6	0.7	2019	Na	Na	0.5	0.6
1982	257	239	-	-	2001	239	11	0.6	0.8					
1983	146	164	-	-	2002	278	17	0.5	0.6					
1984	84	172	-	-	2003	260	9	0.6	0.7					
1985	315	446	-	-	2004	246	9	0.3	0.4					
1986	676	260	-	-	2005	88	7	0.5	0.5					

Hellebaekken

A new monitoring site since 2011. The site is located in Oresund, Denmark (12.55 E; 56.07 N). An eel trap intercept ascending eels from Oresund. There is a reservoir lake above the trap. It was not possible to make an eel pas connecting the lake with the sea. According to the legislation, it is obligatory to establish a corridor to the lake for migrating eel, so a trap was constructed and the captured eel is carried to the lake and released. The National Forest and Nature Agency is handling the eels and reporting the number of captured eel to DTU Aqua.

Picture of the stream Hellebaekken and the house where the eel trap is located. The map shows the location in Oresund.

Table 1.2.3. Ascending eel trapped in Hellebaekken.

Year	Number
2011	638
2012	162
2013	804
2014	87
2015	1380
2016	1793
2017	782
2018	1094

1.2.2 Glass eel recruitment

Weirs in streams are being removed as a part of National river restoration projects e.g. to meet the requirements of the water frame directive. Monitoring young eel recruitment the traditionally way, using eel pass traps, has become more difficult. New methods and locations are urgently needed in order to monitor the effect of the EU regulation in terms of recruitment of young eel from the ocean.

Since 2008 three small brooks situated on the North Sea coast of Jutland were selected for monitoring. At each brook two stations of ca. 20 m length (close to the shoreline <1000 m) are electrofished at three different times from May to August and the population of eels at each station is calculated using the removal method. The brooks have a water depth <50 cm and width of 1–4 m.

The aim is to have this type of monitoring replacing eel pass traps.

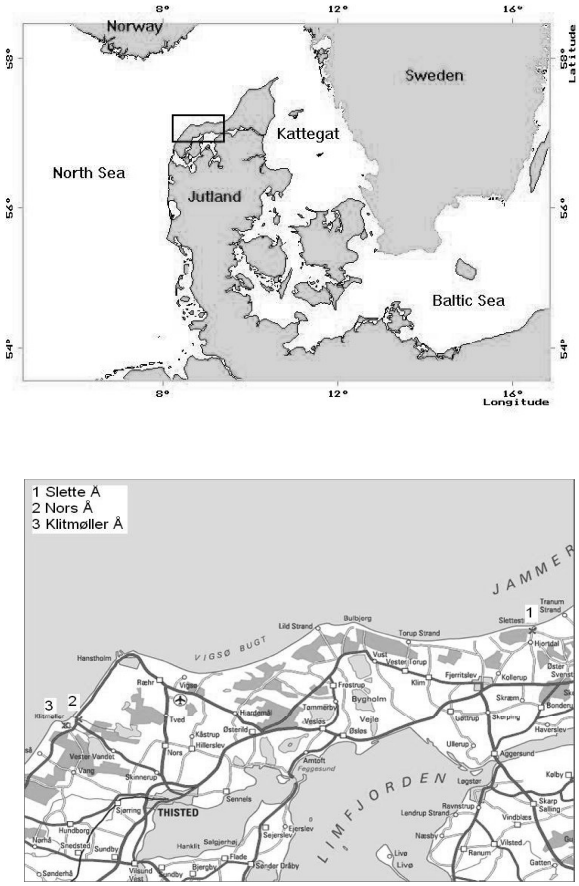


Figure 1.1.2. Map with glass eel monitoring sites (1, 2 and 3) in the North Sea.

Table 1.2.2. Density of newly arrived glass eel pigmented glass eel (eel/m^2) as a mean of three different electrofishing occasions starting medio May to medio August. The maximum density during the season is given.

	Slette Å (1)		Nors Å (2)		Klitmøller Å (3)	
	Mean	Max.season	Mean	Max.season	Mean	Max.season
2008	1.2	1.2	11.8	11.8	2.8	2.8
2009	0.6	1.0	3.9	6.3	1.3	2.2
2010	1.0	1.4	0.3	0.8	0.2	0.2
2011	4.2	5.7	1.0	2.3	0.8	1.2
2012	1.1	1.8	0.8	2.1	0.2	0.2
2013	1.9	2.9	0.9	2.4	0.8	1.8
2014	19.0	29.6	36.8	75.5	13.0	21.4
2015	11.8	27.5	2.8	5.1	0.3	0.3
2016	4.9	6.9	6.9	11.8	1	1.2
2017	1.3	1.9	0.4	0.6	0.9	5.0
2018	35.9	72.9	11.3	17.4	8.3	11.3
2019	6.0	7.4	12.7	27.2	2.1	3.0

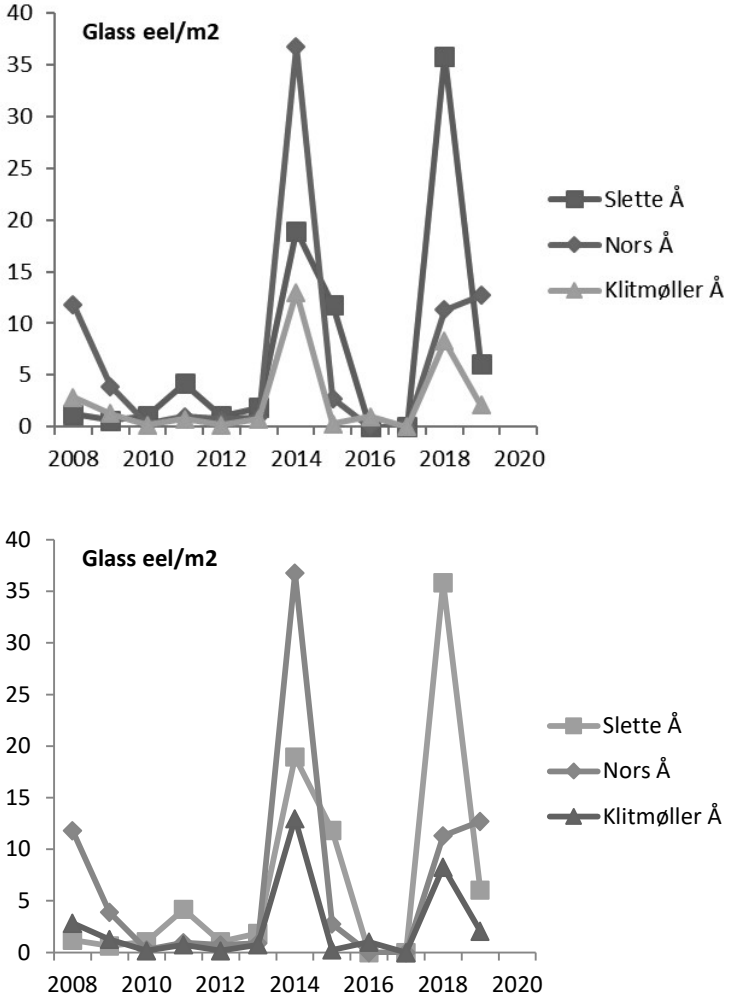


Figure 1.1.3. Monitoring data. Density of newly arrived glass eel pigmented glass eel (eel/m^2) as a mean of three different electrofishing occasions starting mid-May to mid-August.

Slette Å. Monitoring glass eel recruitment by electrofishing. Photo by Jan Skriver.

2 Overview of the stock and its management

2.1 Describe the eel stock and its management

From 1st July 2009 the eel is managed according to the EU regulation, aiming at 40% (relative to the pristine) silver eel escapement in freshwater and 50% effort reduction in the marine waters. The Danish territory is managed as one freshwater EMU excluding two small transboundary river basins named Kruså and Vidå shared with Germany. Intermediate and coastal waters together with community waters constitute the entire marine area.

From 1st July 2009, professional fishing operations are based on licences. The professional fishermen in saline areas are given a licence permitting the use of a limited number of gear in order to meet the 50% effort reduction following the EU eel regulation. Recreational fishermen operating in the marine are permitted to use six fykenets or six hook lines but in a reduced period of the year. Fishing is closed from the 10th of May to 31st of July in order to reduce effort by 50%.

In freshwater a few professional fishermen have a licence permitting the use of a limited number of gears. For landowners and recreational fishermen the open fishing season has been limited to a period of 2.5 months (1 Augustand fishing is closed from 16 October–31 July.

The escapement target of 40% in freshwater has been calculated to be achieved after ca. 85 years if a total ban on freshwater fisheries will commence. Licences are provisionally issued until 31st December every year and have to be renewed. The Ministry of Food, Agriculture and Fisheries may implement further reductions pending the development in the eel stock.

The EU commission has enforced a closing period for commercial and recreational eel fisheries from 1 December 2019 until 1 March 2020.

2.2 Significant changes since last report

There are no changes in eel management since the last country report except the EU enforced closing period. The EU enforced closing period.

3 Impacts on the stock

3.1 Fisheries

3.1.1 Glass eel fisheries

No data; glass eel fishery is forbidden.

3.1.2 Yellow eel fisheries

The commercial time-series on Silver eel landing are shown below see 3.3.1.1 (Freshwater) and 3.3.1.2 (Marine) and recreational see 3.3.2.1.

3.1.3 Silver eel fisheries

The commercial time-series on Yellow eel landing are shown below see 3.3.1.1 (Freshwater) and 3.3.1.2 (Marine).

3.2 Silver eel landings

3.2.1 Commercial

Data on separate landings of yellow and silver eel in fresh and saltwater are given below. Data origin is landing reports by commercial fishermen reported to the ministry. From mid-2009 landings are only reported from those having a licence to fish for eel.

Table 3.3.1.1. Freshwater landings (ton) of yellow and silver eels.

Year	Silver	Yellow	Total	Year	Silver	Yellow	Total	Year	Silver	Yellow	Total
1960	-	-	214	**1980**	-	-	147	**2000**	4	24	28
1961	-	-	235	**1981**	-	-	140	**2001**	2	34	36
1962	-	-	215	**1982**	-	-	163	**2002**	5	27	27
1963	-	-	238	**1983**	-	-	116	**2003**	2	21	24
1964	-	-	223	**1984**	-	-	126	**2004**	4	12	15
1965	-	-	205	**1985**	-	-	111	**2005**	3	10	14
1966	-	-	211	**1986**	-	-	120	**2006**	7	8	14
1967	-	-	243	**1987**	-	-	90	**2007**	5	6	11
1968	-	-	258	**1988**	-	-	119	**2008**	5	4	9
1969	-	-	254	**1989**	-	-	114	**2009**	8	5	13
1970	-	-	249	**1990**	-	-	107	**2010**	10	3	13
1971	-	-	183	**1991**	-	-	99	**2011**	11	4	15
1972	-	-	200	**1992**	-	-	109	**2012**	9	4	13
1973	-	-	201	**1993**	-	-	57	**2013**	10	3	13
1974	-	-	163	**1994**	-	-	60	**2014**	12	3	15
1975	-	-	260	**1995**	-	-	52	**2015**	9	6	15
1976	-	-	178	**1996**	-	-	34	**2016**	10	3	13
1977	-	-	179	**1997**	-	-	39	**2017**	12	5	16
1978	-	-	157	**1998**	-	-	40	**2018**	6.5	5	11.5
1979	-	-	78	**1999**	-	-	30	**2019**	NA	-	-

Table 3.3.1.2. Marine landings (ton) of yellow and silver eels.

Year	Silver	Yellow	Total	Year	Silver	Yellow	Total	Year	Silver	Yellow	Total
1960	2756	1967	4509	**1980**	911	1230	1994	**2000**	382	218	572
1961	2098	1777	3640	**1981**	897	1190	1947	**2001**	446	225	635
1962	2132	1775	3692	**1982**	1003	1375	2215	**2002**	365	217	555
1963	1837	2091	3690	**1983**	884	1119	1887	**2003**	437	188	601
1964	1417	1865	3059	**1984**	830	915	1619	**2004**	343	187	516
1965	1498	1699	2992	**1985**	793	726	1408	**2005**	372	149	506
1966	1829	1861	3479	**1986**	818	734	1432	**2006**	427	154	567
1967	1673	1763	3193	**1987**	538	651	1099	**2007**	411	115	515
1968	2063	2155	3960	**1988**	799	960	1640	**2008**	364	93	448
1969	1552	2072	3370	**1989**	785	797	1468	**2009**	367	87	454
1970	1470	1839	3060	**1990**	834	734	1461	**2010**	304	105	409
1971	1490	1705	3012	**1991**	724	642	1267	**2011**	271	84	355
1972	1662	1567	3029	**1992**	687	655	1233	**2012**	226	78	304
1973	1697	1758	3254	**1993**	523	500	966	**2013**	243	100	343
1974	1378	1436	2651	**1994**	509	631	1080	**2014**	251	80	331
1975	1534	1691	2965	**1995**	408	432	788	**2015**	202	65	267
1976	1477	1399	2698	**1996**	381	336.5	684	**2016**	178	74	251
1977	1141	1182	2144	**1997**	375	383	719	**2017**	170	70	240
1978	1187	1148	2178	**1998**	306	251	517	**2018**	88	82	170
1979	887	939	1748	**1999**	380	307	657	**2019**	Na	-	-

3.2.2 Recreational

Freshwater

Recreational fishermen in freshwater are landowners and do not need a licence to fish. The fishing season is open from 1 August until 15 October and closed from 16 October until 31 July.

Marine

Recreational fishermen in the marine area are allowed to use a maximum of six fykenets. The fishing season is open from 1 August to 9 May and closed from 10 May to 31 July. Landing data are based on interview survey among recreational fishermen (Sparrevohn og Storr-Paulsen, 2010).

The survey (Table 3.3.2.1) is based on interviews from recreational fishermen from both the marine and freshwater. The data should be treated with care and the author believe especially the freshwater catch may be biased (far too high) during 2015 and 2016.

Table 3.3.2.1. Recreational landings in ton (yellow eel), based on interview from people holding a recreational licence (marine) or landowners (freshwater).

Year	Fresh	Marine	Total
2009	NA	100	100
2010	NA	117.5	117.5
2011	4.3	75.2	79.5
2012	0.4	51.9	52.3
2013	0.4	49.5	49,9
2014	2.0	55.0	57.0
2015	23.3	95.0	118.3
2016	10.2	154.1	164.3
2017	8.3	109	117,3
2018	3.5	101.5	105.0

3.3 Restocking

In 2019 a total of 1.810 million 2–5 gram eels were stocked. In freshwater 1.625.000 million eel and in marine waters 0.185 million were stocked (Table 3.5.1 below).

The stocked eels are foreign source imported from France, England and Portugal. Imported glass eels are grown to a weight of 2–5 gram in heated culture before they are stocked.

Table 3.5.1. Restocking of elvers (2–5 g) in marine and freshwaters from 1987–2019. Numbers of eels stocked (in millions).

Year	Marine	Lake	River	Total	Year	Marine	Lake	River	Total
1987	0.07	0.26	1.26	1.58	**2004**	0.52	0.18	0.06	0.75
1988	0.11	0.24	0.4	0.75	**2005**	0.24	0.06	0	0.3
1989	0	0.24	0.17	0.42	**2006**	1.15	0.35	0.1	1.6
1990	2.46	0.49	0.51	3.47	**2007**	0.59	0.21	0.02	0.83
1991	2.3	0.44	0.32	3.06	**2008**	0.52	0.19	0.04	0.75
1992	2.94	0.81	0.11	3.86	**2009**	0.55	0.20	0.05	0.81
1993	2.97	0.76	0.23	3.96	**2010**	0.30	0.57	0.67	1.55
1994	6.12	0.61	0.67	7.4	**2011**	0.20	0.77	0.59	1.56
1995	6.83	0.72	0.9	8.44	**2012**	0.25	0.64	0.64	1.53
1996	3.58	0.58	0.44	4.6	**2013**	0.25	0.66	0.61	1.52
1997	2.02	0.29	0.22	2.53	**2014**	0.26	0.71	0.63	1.60
1998	2.35	0.53	0.1	2.98	**2015**	0.13	0.79	0.61	1.53
1999	3.38	0.56	0.18	4.12	**2016**	0.13	0.69	0.71	1.53
2000	3.02	0.55	0.25	3.83	**2017**	0.13	0.69	0.71	1.52
2001	1.2	0.38	0.12	1.7	**2018**	0.13	0.67	0.31	1.11
2002	1.66	0.47	0.3	2.43	**2019**	0.18	0.88	0.75	1.81
2003	1.54	0.49	0.22	2.24					

3.4 Aquaculture

Aquaculture production of eel in Denmark started in 1984. The production takes place at three indoor, heated aquaculture systems, Table 3.3.1.

Glass eels to Danish aquaculture may be imported from France, Portugal or England. The eel farmers report to the Danish AgriFish Agency what amount of glass eel is imported but not from where it is imported. Data up to 2017 are currently available.

Table. 3.3.1. Annual aquaculture eel production.

Year	Production Units	Production [ton]	Year	Production units	Production [ton]
1984	NA	18	2001	17	2000
1985	30	40	2002	16	1880
1986	30	200	2003	13	2050
1987	30	240	2004	9	1500
1988	32	195	2005	9	1700
1989	40	430	2006	9	1900
1990	47	586	2007	9	1617
1991	43	866	2008	9	1740
1992	41	748	2009	9	1707
1993	35	782	2010	9	1537
1994	30	1034	2011	8	1156
1995	29	1324	2012	8	1093
1996	28	1568	2013	8	824
1997	30	1913	2014	6	842
1998	28	2483	2015	5	1234
1999	27	2718	2016	5	1072
2000	25	2674	2017	3	561
			2018	3	NA

Table 3.2.1. Usage of aquaculture production 2017 (Source: Danish AgriFish Agency).

	Number	Kg
Imported glass eel	10 263 750	4168
Stocking in Dk, size 3,5 g	1 106 000	3871
Stocking exported, size 9 g	1 926 338	17 337
Large eel consumption		531 892
Dead biomass		8100
Total production		561 200

The import and export data **Table 3.2.1** are reported by the eel farmers to the Danish AgriFish Agency. The different categories (import, stocking) are reported in kg and in numbers. The categories stocking export, consumption and dead biomass is reported in numbers. Life mortality from the glass eel stage to the stocked eel stage or the consumption stage is the same level, approximately 5–15 %. It should be noted that the number of glass eel imported to the farm is not necessarily comparable to the number of eel from the farm the same year. The retention time of eel in the farm differs by eel stage, e.g. eel for stocking is 3–12 months and eel for consumption is 18 months or more.

3.5 Entrainment

Hydropower

In 2006 there were 43–61 hydroelectric power units in operation in Denmark. Since then several hydropower units have been closed down (e.g. Vilholdt, Karlsgårdeværket, Harteværket, Holstebro vandkraft, etc). There are no exact data on the number and the capacity of hydroelectric power units at present.

We have measured a loss of 0 and 58% at two particular hydro-power plants. At Tange Hydropower plant there is a significant bypass problem for eels, we have measured a loss of at least 58% (Pedersen *et al*., 2011). At Vestbirk hydropower the fish bypass (¼ of the water discharge) in combination with 10 mm screens works well and the loss is close to zero. (Pedersen and Jepsen, 2012).

We have no data for other hydro-power plants.

Trout farms (aquaculture)

Research in relation to weirs of trout farms have been conducted in connection with three trout farms in River Kongeåen and River Mattrup Å. The conclusion from these studies was that delay of eel migration due to low discharge was observed in some years and the eels bypass the screens that were supposed to prevent eels and other species to enter the trout farm.

Danish trout farms are often located on the banks of rivers depending on water intake from the rivers. To guide the river water into the trout farm, a weir is built in the river. Less than 250 trout farms use "flow through" river water and approximately ten have systems for recirculation of water. To prevent fish from entering the trout farms a screen with a maximum 6 mm bar distance is obligatory at the point of the water inflow and a maximum 10 mm bar distance at the point of outflow.

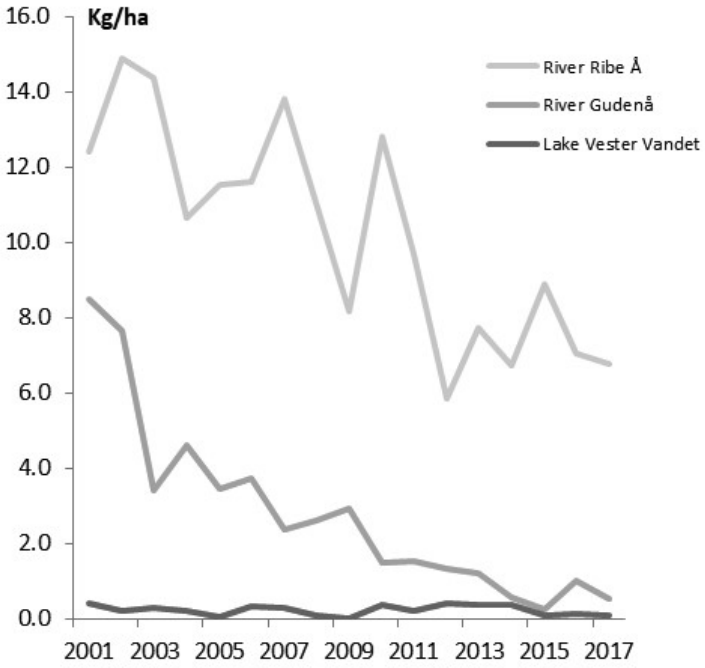
Two studies have been conducted. The first study was at Brejnholt trout farm in River Mattrup Å. Here no mortality was observed but migration delay of silver eels at the weir varied with water discharge. The second study was in River Kongeå, here two trout farms are situated on the bank of the river at Vejen and Jedsted. Both trout farms have 6 mm bar distance at the water intake. At Vejen fish farm several fish entered the fish farm despite the 6 mm bar screen which seems not correctly installed or damaged. At Jedsted no fish entered the fish farm and the screen was working well. If the screen at Vejen fish farm is fixed properly, eels would not be able to enter the fish farm. However, it is quite difficult to see by eye if there is any such problem at other comparable fish farms unless the place where the screen is mounted is dried out.

The conclusion from these studies is that migrating silver eels is likely to have migration delay at weirs, which may depend on the hydrological conditions (water discharge) at some weirs and at other the screens may be incorrect mounted, causing eels to be trapped at the trout farm. No mortality was observed but delay at weirs is likely to cause higher mortality from predators (Pedersen and Jepsen, 2012).

3.6 Habitat Quantity and Quality

The spatial distribution of weirs in relation to hydropower and "flow through trout farms" are geographical limited to Jutland. No updated data since 2006 (see above) on quantity and quality is available.

It was assumed that about 10 ton of eel would die in connection with these weirs throughout the Danish inland waters!



3.7 Other impacts

Nothing to report.

4 National stock assessment

4.1 Description of Method

4.1.1 Data collection

1. Commercial fishermen are obliged to report through logbooks to the ministry of fisheries Landings in weight are separated in yellow and silver eel landings.
2. Recreational fisheries catch are collected through yearly interview surveys.
3. Recruitment data are monitored in freshwater using eel pass traps and electrofishing surveys.
4. Silver eel escapements from all 887 Danish river systems are surveyed using three index river systems. Two river systems with a silver eel trap and one river system with a commercial fisherman (Ribe Å).

Analysis
At River Ribe Å we use tag–recapture to estimate escapement (Petersen estimate, Ricker 1981). The depletion method is used when river population estimates are made by electrofishing.

4.1.2 Reporting

Collected data are published in national reports or international journals, WGEEL CR reports or Eel management progress reports to the EU- commission.

4.2 Trends in Assessment results

Stock indicators
Data from these index systems are used to calculate the total silver eel escapement from the Danish freshwater territory. The count is repeated at least every three years. The National Institute of Aquatic Resources (DTU Aqua) has succeeded in estimating and counting escaping silver eels from River Ribe Å, upper part of River Gudenå and Lake Vester Vandet.

5 Other data collection

5.1 Recruitment time-series

Glass eel surveys are described under Section 1 of this country report.

5.2 Yellow eel abundance surveys

The monitoring in Vester Vedsted may be recognized both as a yellow eel abundance survey as well as recruitment survey. No other surveys are available!

5.3 Silver eel escapement surveys

Described in Section 4 of this country report.

5.4 Parasites and Pathogens

The swimbladder parasite *Anguillicola crassus* is widely distributed throughout both brackish and freshwaters in Denmark. Monitoring of Anguillicola parasites takes place on a yearly basis at three locations since 1987. The number of Anguillicola infected eels (prevalence) is relatively constant during 1987–2017 at all three locations.

Table 11.2. Anguillicola monitoring data 2015.

Location	Salinity ppt	Coordinates	Year	Total	Infected	Prevalence	Intensity
				N	N	%	n
Isefjord	18	55.50N;11.50E	2018	95	24	25.3	1.2
Ringk. Fjord	5–10	55.55N;08.20E	2018	92	68	73.9	6.4
Arresø	0	55.59N;11.57E	2018	106	51	48.1	2.3

5.5 Contaminants

No new data available.

5.6 Predators

Cormorants

Cormorants are possibly the only important predator of eel due to the large number of nesting birds; predation is expected to be largest in the vicinity of the colonies, but birds migrating through Denmark may have significant impact during the fall.

The number of cormorants nesting in Denmark during the last 10–15 years can be regarded as stable, but with some fluctuation. The number of nests is now in an upward trend since 2010–2013. In the year 2000 the highest number of nests 42 481 was counted in colonies throughout Denmark. In 2017 a total of 33 171nests were counted.

In the Danish EMP (2008) it was suggested that in the period 2004–2006 approximately 80 tonne of yellow eel was eaten by cormorants. However recent work from Hirsholmene (57.29'N; 10.37'E) a cormorant colony in Kattegat analysing 350 regurgitated pellets, showed that eel otoliths occurred with a frequency of 0.3% (Poul Hald, 2007). The frequency of occurrence of eel otoliths found in cormorant pellets in 2005 was 0.12% and Sonnesen (2007) suggesting that wild eels are not important as food in Ringkøbing Fjord (55.55'N;08.20'E). However despite this low occurrence, the estimated number of eels eaten in Ringkøbing Fjord by cormorants in 2004 was 38 000, more individuals than was caught in the fishery, and recovery of cw-tags from 20 000 tagged stocked eels showed a 40% predation from cormorants during the first season (Jepsen *et al*., 2010). Thus cormorant predation can be a very significant factor in areas with a high cormorant density. The number of cormorants in Ringkøbing Fjord is not higher than most coastal areas in Denmark.

Recent analyses of data from ongoing studies of silver eel migration, using PIT tagging, showed that even relative large silver eels can be eaten by cormorants as PIT tags were recovered from nearby colonies and roosting sites. The recoveries may provide a basis for quantification of the predation in future studies.

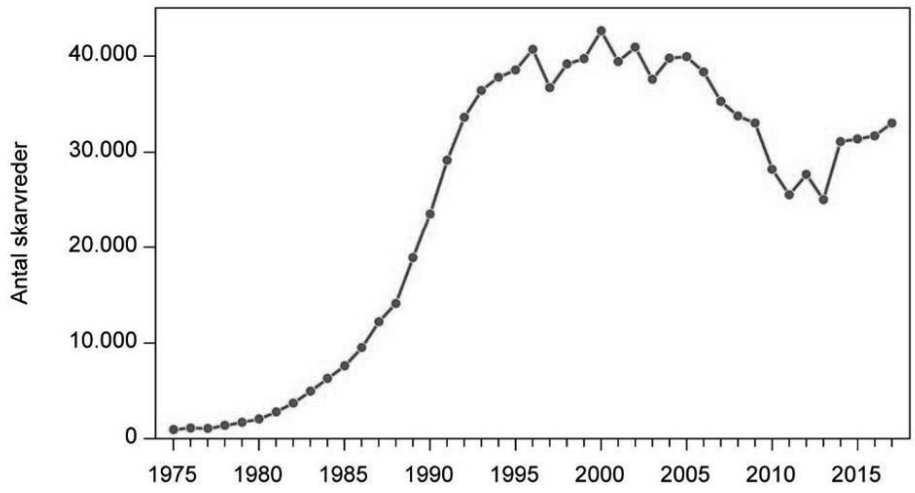


Figure 5.6. Number of cormorant nests in Denmark 1971–2017. Data from NERI. University of Århus.

6 New Information

6.1 New papers

Christoffersen, M., Svendsen, J.C., Kuhn, J.A., Nielsen, A., Martjanova, A., Støttrup, J.G. 2018. Benthic habitat selection in juvenile European eel *Anguilla anguilla*: implications for coastal habitat management and restoration. Journal of Fish Biology, Volume 93, pages 996–999.

The critically endangered European eel *Anguilla anguilla* is dependent on suitable habitat qualities over a vast geographic area. Even though a significant proportion of the population never enters freshwater, the preferred benthic habitat is largely unknown in the marine environment. Examining substratum selection in *A. anguilla* reveals that elvers prefer coarse gravel, suggesting that conservation efforts may benefit from targeting this type of substratum in marine coastal areas.

Pedersen M. I. Jepsen N. Rasmussen G. 2017. Survival and growth compared between wild and farmed eel stocked in freshwater ponds. Fisheries Research, Volume 194, October 2017, pages 112–116.

To evaluate the efficiency of eel stocking, we compared the survival and growth of wild eels (2–5 g) with that of "farmed" eels (3–6 g). Wild eels were caught in a river and farmed eels came from a farm, where wild imported glass eels are cultured. Two experiments of 5–12 month duration were conducted in a series of shallow, open ponds of approximately 200 m^2. Wild and farmed eels were batch tagged, mixed and released in the ponds at an initial density of 0.5 individual /m^2. Survival was rather high (34–88%) with variations between ponds. No significant difference in survival was found between wild and farmed during the first 5 month in both experiments. Growth rates were significantly higher for farmed eels compared to wild eels in both experiments. The results show that farmed eels performed better than wild eels. In regions with low recruitment the eel population may be increased by importing glass eels, stocked directly or stocked as on-grown farmed eel. The optimal size for stocking (between glass- and 3 g eels) may be determined through future studies.

Pedersen M.I. and G. H. Rasmussen. 2018. Fisheries regulation on European eel (*Anguilla anguilla*) for 2018; how big is the effect? Journal of fisheries Research. Volume 2 page 17–18.

The EU Council of Ministers decided in December 2017 to implement a limitation on commercial marine catches on eels exceeding 12 cm in length for 2018. We aimed to evaluate the effect of the fishing limitation using data on actual and potential silver eel escapement (stock indicators). The data suggest that fisheries exploitation of adult eels in the marine areas has relatively little effect on the biomass of silver eel that potentially can escape to the spawning grounds in the Sargasso Sea. The 2018 fishing regulation for the marine commercial fisheries increases migrating of silver eels towards the spawning grounds in the Sargasso Sea, from expected 10 000 t to 10 200 t, equivalent to 2% increase. Other anthropogenic mortality and predation may be far more important than landings of all life stages and account for 49% of the total loss.

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