Report on the eel stock, fishery and other impacts, in:

Germany

2024

Note to the reader - this document accompanies a series of spreadsheet tables that provide the bulk of the data in a format most suitable for the working practices of the WGEEL. Summaries of these data are provided in this document.

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1 Updates to the previous report

All tables were updated with data up to 2022

Tables on fisheries, recruitment, restocking, and aquaculture production were removed. This data is now available in the WGEEL database: https://mercure.eptb-vilaine.fr/shiny_dv/

2 Stock status summary

Table 1. Stock indicators of silver eel escapement, biomass and mortality rates and assessed habitat area (Data from 2022).

EMU_code	Assessed Area (ha)	B_0 (kg)	B_{curr} (kg)	B_{best} (kg)	Bcurr/B_0 (%)	∑F	∑H	∑A
DE_Eide	468,783	1,708,219	295,299	309,257	17.3	0.03	0.01	0.04
DE_Elbe	201,019	1,630,223	313,884	56,540	19.3	0.41	0.19	0.60
DE_Ems	44,088	925,226	175,258	111,104	18.9	0.06	0.01	0.08
DE_Maas	892	9,021	518	86	5.7	0.02	0.05	0.07
DE_Oder	80,366	444,921	102,873	95,351	23.1	0.12	0.00	0.12
DE_Rhei	61,065	540,333	183,339	11,117	33.9	0.22	0.41	0.63
DE_Schl	33,379	4,205,010	2,259,462	1,760,155	53.7	0.03	0.00	0.03
DE_Warn	368,309	902,850	469,200	513,271	52.0	0.18	0.00	0.18
DE_Wese	55,472	828,397	239,620	72,641	28.9	0.19	0.13	0.32

Key:
EMU_code = Eel Management Unit code (see sheet 'EMU names and codes' for list of codes)
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)

3 Overview of the stock and its management

3.1 Describe the eel stock and its management

This report provides the most recent information about eel stocks, eel fishery and eel surveys in Germany. The corresponding data are made available through WGEEL Data Calls and EMP Progress Reports. In Germany, inland fishery is under the legal competence and responsibility of the Federal States ("Bundesländer"). The relevant authorities and institutions in the states mainly focus on the requirements of the Progress Reports to the European Commission and not on providing detailed data on an annual basis. This is mainly caused by limited resources and capacities of the regional fisheries authorities. Currently, most data are available until 2022.

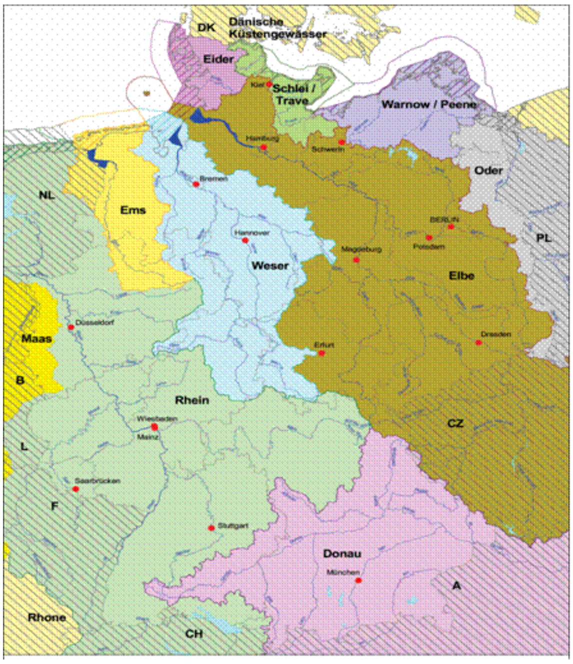

Figure 1: River Basin Districts (RBDs) in Germany (Source: Umweltbundesamt 2004).

In December 2008, Germany has submitted Eel Management Plans (EMPs) for all River Basin Districts (RBDs) (Fig. 1) that constitute a natural habitat for the European eel, as required by the Council Regulation (EC) No 1100/2007. EMPs have been prepared for nine EMUs (Baltic Sea: Eider, Oder, Schlei/Trave and Warnow/Peene; North Sea: Elbe, Ems, Meuse, Rhine and Weser). No EMP was prepared for the river Danube, since according to an EC decision, the Danube does not constitute a natural distribution area for eel in the sense of the Council Regulation (EC) No 1100/2007.

The German Eel Model (version GEM IIIc, Oeberst & Fladung, 2012) has been used in all nine German EMUs to calculate the eel population parameters.

New rules from EMPs have become part of regional fisheries laws and/or fisheries regulations in the respective states.

3.2 Significant changes since last report

There were no significant changes since the last country report.

4 Impacts on the stock

4.1 Fisheries

4.1.1 Glass eel fisheries

There is no glass eel fishery in Germany

4.1.2 Yellow and silver eel fisheries

Reported commercial and estimated recreational yellow and silver eel landings are available in the WGEEL database: https://mercure.eptb-vilaine.fr/shiny_dv/

Commercial eel fisheries in Germany are usually mixed fisheries, targeting different species and both eel stages, yellow and silver eel (though some gears primarily target one of these stages). Commercial eel landings are recorded by fishers and reported to regional authorities. Landings of yellow and silver eels have not been reported separately in the past, but separated reporting has been implemented in some EMUs during last years. Potential underreporting is not considered in the landings data.

Recreational eel landings data from Germany are not collected in most EMUs and therefore usually estimated based on the total number of fishing licences per EMU. For the calculation, data from Fladung et al. (2012a) were used, who found that about 58% of all anglers in the river Havel system fished for eel, and of these about one third was successful. In relation to the total number of valid fishing licenses, the annual yield was 0.6 eels or 288 g eel per angler in this system. Similar results have been found for the State Mecklenburg-Pomerania in earlier studies (Dorow & Arlinghaus 2008, 2009). It must be stressed that these data provide only very rough estimates and that the accuracy of the figures presented here is low. Only in some EMUs (DE_Elbe, DE_Wese), recreational landings data are directly collected.

Fishing effort. The main fishing gears for eel in Germany are fyke nets (different types), among which the "small fykes" are the most important group. Since 2008, a notable effort reduction in small fyke net (-32%) and stow net fisheries (-68%) was observed. All other gears also showed a reduction in effort. Highest reductions were reported for hook buoys and stationary traps, however, these gears only account for a small fraction of the total fishing effort on eel in Germany.

*Table 2: Fishing effort (yellow and silver eels) with the most relevant eel fishing gears of commercial and semi-commercial fisheries in German waters in 2022 and change (%) in relation to the 2008. Data are presented as gear*days (Source: German Progress Report (Fladung & Brämick 2024)).*

EMU	Small fykes	Large fykes	Longlines/eel line (per 100 hooks)	Hook buoys	Stow nets	Stationary eel traps	Electro fishing
DE_Eide	5,402	2,727	0		30	0	0
DE_Elbe*	230,240	244,264	25	6,176	618	141	4
DE_Ems	1,165	3,667	0		1,779	0	0
DE_Maas	0	0	0		0	0	0
DE_Oder	101,770	8,272	3,868	200	192	0	1
DE_Rhei	130,161	3,469	120		54	0	277
DE_Schl	1,482,371	18,569	301		0	0	0
DE_Warn	2,027,770	37,282	108,991	911	0	169	39
DE_Wese	234,882	6,193	0	0	748	0	0
Total	4,213,761	324,443	113,305	7,287	3,421	310	321
Change from 2008 to 2024 (%) *, **	**-32**	**-8**	**-39**	**-89**	**-68**	**-86**	**-36**

*Without Hamburg, because no data were reported. **Without the State of Brandenburg, because data for 2008 are not available.

4.2 Restocking

Data on eel restocking in German EMUs is available in the WGEEL database: https://mercure.eptb-vilaine.fr/shiny_dv/

4.3 Aquaculture

Data on German eel aquaculture production is available in the WGEEL database: https://mercure.eptb-vilaine.fr/shiny_dv/

Data on aquaculture production is provided annually by the Federal Statistical Office and data on the use of aquaculture production is provided in the yearly report on freshwater fisheries (Brämick & Schiewe 2023). Data on use/life stage of produced eels are separated into ongrown eels (used for stocking) and yellow/silver eels at marketable size (mostly for human consumption).

Data on use/life stage is not reported for the years before 2015, because there was a drastic decline in the quantity of ongrown eels from 2014 to 2015, with an equivalent increase in the production of yellow/silver eels for human consumption. Since reporting in 2015 was consistent with the following years and the number of ongrown eels prior to 2015 was unrealistically high, only total aquaculture production is given for earlier years.

4.4 Entrainment

Impacts of technical installations (e.g., hydropower turbines, in some instances cooling water intakes etc.) are considered in the German Eel Model. The model assumes that turbines damage only silver eels, although there are also some effects on yellow eels during movements within the rivers. Estimation of the turbine mortalities are based on EMU specific estimates or an estimated average mortality of ~30% less a percentage for protection devices.

According to the position of the obstacles and the known or estimated mortality rates at each location, the EMUs can be divided into several sub-areas, for each of which the cumulative turbine mortality down to the estuary can be calculated. By using a step size of ten per cent, the whole system can be divided into ten sub-areas of similar turbine mortality. Based on this stratified structure, the overall impact of technical obstructions on eels is calculated per EMU. However, this modelling approach assumes equal distribution of eels in EMUs, while it is likely that the abundance is higher in downstream regions. Comprehensive information on the spatial distribution of these impacts is currently not available, but a "hydropower module" is to be developed for a better estimation of hydropower related mortality.

4.5 Habitat Quantity and Quality

So far, aspects of habitat quality are only considered indirectly by including the effects of technical obstructions at barriers (see above) and predation by cormorants in the GEM. However, effects of contaminants, diseases or parasites so far cannot be quantified and are therefore not considered.

4.6 Others

Predation by cormorants is included in the GEM. Estimates are based on numbers of cormorants in the relevant regions and proportion of eels in their diet.

5 National stock assessment

5.1 Description of Method

Stock indicators are calculated with the German Eel Model IIIc (GEM IIIc). The model calculates the cohort development separately for males and females and is also used to estimate mortality rates. A description of the previous version (GEM II) has been published by Oeberst & Fladung (2012).

The model incorporates weight and sex of eels as well as the mean water temperature to estimate the natural mortality. Natural mortality was estimated based on Bevacqua et al. (2011) with three density levels. The areas given in the EMPs and in the reports include all potential eel habitats. Only some habitats e.g. in the trout region, far away from the coast may have been excluded, because these areas are no typical eel habitats. Areas above impassable barriers are also included in the calculation of escapement. In agreement with Council Regulation (EC) No 1100/2007, coastal waters have been included in some EMUs. In case, coastal waters are not included, fisheries have been reduced by 50% outside the areas covered by the EMP.

All estimates refer to the whole EMU without assuming differences within the system except for hydropower mortality (see chapter 4.4). It is obvious that there will be differences between different habitat types, but the available data do not allow for a more differentiated approach. As a consequence, the values represent a mean value for the whole EMU. In addition, some of the input data are still not available for each EMU. In these cases, values from the EMU Elbe were used. Though based on knowingly inaccurate assumptions, this is regarded the best possible approach. The model predictions have been compared to empiric data by tagging experiments and empirical monitoring of silver eel escapement. These experiments largely supported model estimates, at least in the order of magnitude in the Elbe and Schwentine river systems, but also showed that the accuracy of model input parameters is crucial to receive realistic model outputs (Fladung et al. 2012b, Prigge et al. 2013). A recent study in the EMU Ems showed a strong overestimation of the modelled values for silver eel escapement compared to numbers determined empirically with a mark-recapture study in the main stream of the Ems (Höhne et al. 2023). This result underscores the tendency of GEM IIIc to overestimate silver eel escapement (Höhne et al. 2024), which has already been shown in the other validation studies (Fladung et al. 2012a, Prigge et al. 2013, Marohn et al. 2014, Brämick et al. 2015).

Restocking is not included in the calculation of B_0 and B_{best}. $B_{current}$ includes the effect of restocking in all EMUs, where restocking applies. The values of $\sum A$ represent real mortalities and are not lowered by restocking.

German eel management plans are available via this link (in German): https://www.portal-fischerei.de/bund/bestandsmanagement/aalbewirtschaftungsplaene

German Progress Reports are available via this link (in German): https://www.portal-fischerei.de/bund/bestandsmanagement/aalbewirtschaftungsplaene/umsetzungsbericht

5.1.1 Data collection

The main input parameters of the GEM IIIc are fisheries yield (commercial (from national landing statistics) and recreational), stocking and estimates for natural immigration based on the ICES recruitment time series, predation by cormorants, other natural mortality, and mortality by hydropower. Eel stock and silver eel escapement is given by number and biomass, based on growth functions and length-weight relationships. For details see Oeberst & Fladung (2012).

In the European Commission's Data Collection Framework (DCF), morphometric and age data on eel from all EMUs are regularly assessed (depending on end-user need).

5.1.2 Analysis

A description of the basic model has been given by Oeberst & Fladung (2012). An example of how the model can be used for management consideration has been given by Brämick et al. (2015).

5.1.3 Reporting

The results are presented in the EMP Progress Reports according to the Council Regulation (EC) No 1100/2007 and in the annual WGEEL Country Reports.

EMP Progress Reports are available via this link (in German): https://www.portal-fischerei.de/bund/bestandsmanagement/aalbewirtschaftungsplaene/umsetzungsbericht/?no_cache=1&sword_list%5B%5D=Aal

WGEEL Country Reports are available at the ICES library: https://ices-library.figshare.com/

5.1.4 Data quality issues and how they are being addressed

The model used to calculate the different population parameters of eel in German waters (Oeberst & Fladung 2012), has been further developed and improved (GEM IIIc) and has also been tested in the frame of the POSE project. The model results have been compared to data obtained by tagging studies and are considered acceptable (Fladung et al. 2012b, Prigge et al. 2013). Yet, the studies also indicated that the quality of the results strongly depends on the quality of the input data. However, as described in chapter 5.1, a recent study in the EMU Ems showed a significant overestimation of the modelled values for silver eel escapement compared to numbers determined empirically (Höhne et al. 2023). The consistent tendency towards an overestimation of silver eel escapement in GEM validation studies (Höhne et al. 2024) indicates that not only quality issues of the input data, but also inadequate assumptions in the model structure could be causing overly optimistic outcomes (Höhne et al. 2023, 2024). A sensitivity analysis is in progress to quantify the impact of single input parameters on the model output.

5.2 Assessment results

Modelled fishing and other anthropogenic mortality rates have decreased in all EMUs since the 2005-2007 time period except in DE_Warn (Tab. 3), where the increasing mortality rate is partly explained by a change in population size (Fladung & Brämick 2024). In absolute numbers, mortalities due to fisheries (i.e. landings) and hydropower (i.e. eels lost to turbines and cooling water intakes) declined in all German EMUs (Tab. 4 & 5).

Apart from the considerable influence of stocking on recruitment and differences in fishing intensity, the vast differences in anthropogenic mortalities between EMUs can be explained by the inclusion of coastal habitats with comparably low mortalities in some EMUs (DE_Schl, DE_Warn, DE_Eide).

It should be noted that although other anthropogenic mortalities are presumed to be almost exclusively caused by hydropower, ΣH is not considered a good indicator for the development of mortality at hydropower plants and pumping stations. A detailed explanation is given by Fladung & Brämick (2024). Briefly, anthropogenic mortalities were calculated for every year separately (and not for a given cohort) and are thus linked to yearly recruitment. Accordingly, the effect of measures will only be fully represented in these figures, once the stock is fully comprised of cohorts that are affected by these measures and the results refer to the whole stock. To get a more realistic picture, hydropower losses were calculated separately based on the fraction of silver eels only, which revealed that hydropower mortality rate remained constant in 5 out of 9 EMUs over the observed time period (Fladung & Brämick 2024).

Table 3: Development of anthropogenic mortality rates after the implementation of eel management plans (Source: German Progress Report (Fladung & Brämick 2024)).

EMU	∑F			∑H			∑A		
	Ø 2005-07	Ø 2020-22	Change (%)	Ø 2005-07	Ø 2020-22	Change (%)	Ø 2005-07	Ø 2020-22	Change (%)
DE_Eide	0.03	0.03	-16	0.01	0.01	-23	0.02	0.01	-17
DE_Elbe	0.89	0.42	-52	0.25	0.18	-27	1.15	0.61	-47
DE_Ems	0.11	0.07	-39	0.01	0.01	-19	0.03	0.02	-37
DE_Maas	0.97	0.03	-97	0.08	0.05	-36	1.06	0.08	-93
DE_Oder	0.22	0.16	-25	0.02	<0.01	-92	0.9	0.2	-30
DE_Rhei	0.32	0.23	-28	0.5	0.45	-10	0.55	0.42	-17
DE_Schl	0.07	0.03	-56	<0.01	<0.01	-37	0.01	0.05	-55
DE_Warn	0.14	0.19	33	<0.01	<0.01	-41	0.24	0.29	33
DE_Wese	0.31	0.24	-23	0.16	0.13	-20	0.27	0.17	-22
Total	0.18	0.13	-29	0.06	0.05	-23	0.12	0.6	-27

Table 4: Eel landings from commercial and recreational fishing (in tons) in Germany by EMU. Change is calculated as the average from 2005-2007 compared to the average of 2020-2022 (Source: German Progress Report (Fladung & Brämick 2024)).

EMU	2005	2006	2007	2020	2021	2022	Change (%)
DE_Eide	29	28	25	6	6	6	-79
DE_Elbe	297	313	299	196	194	186	-37
DE_Ems	34	32	25	12	12	11	-62
DE_Maas	0.4	0.4	0.4	0.1	0.1	0.1	-85
DE_Oder	28	28	28	22	22	21	-23
DE_Rhei	139	141	139	68	62	65	-54
DE_Schl	80	78	61	47	45	45	-37
DE_Warn	144	151	129	95	95	89	-34
DE_Wese	100	100	94	69	62	58	-36
Total	853	871	799	514	496	481	-41

Table 5: Estimated losses of silver eels due to hydropower and selected cooling water intakes (in tons) in Germany by EMU. Change is calculated as the average from 2005-2007 compared to the average of 2020-2022 (Source: German Progress Report (Fladung & Brämick 2024)).

EMU	2005	2006	2007	2020	2021	2022	Change (%)
DE_Eide	25	22	18	3	3	3	-86
DE_Elbe	173	125	90	87	93	97	-29
DE_Ems	6	5	5	2	2	2	-66
DE_Maas	<1	<1	<1	<1	<1	<1	-61
DE_Oder	3	3	2	<1	<1	<1	-94
DE_Rhei	388	398	395	157	143	150	-62
DE_Schl	4	4	4	2	2	3	-43
DE_Warn	<1	<1	<1	<1	<1	<1	-77
DE_Wese	84	79	73	36	42	45	-48
Total	684	636	589	288	285	300	-54

6 Other data collection

6.1 Recruitment time series

At present, five German recruitment time series are included in the international assessment (Frische Grube (‘WiFG’), Wallensteingraben (‘WisWGY’), Dove Elde eel ladder (‘DoElY’), Verlath Pumping Station (“VerlGY”) and Broklandsau Pumping Station (BrokGY)).

Baltic Sea: Since the early 2000s, immigration and upstream migration of young eels have been monitored at 3 locations in the EMU DE_Warn (WisWGY, FarpGY, WiFG). Since these time series did not assess elvers and glass eels separately, a new time series was set up in 2016 directly in the Warnow River, where elvers and glass eels are reported separately (WaSG and WaSEY). The current annual natural settlement rate in coastal waters in the southern Baltic was estimated Based on an enclosure monitoring system (Dorow et al. 2023).

North Sea: In EMU DE_Eide, ascending eels are monitored at three stations (VerlGY since 2010, BrokGY since 2012, LangGY since 2015). The monitoring is trend based as the catching system (trapping ladder) is not able to catch quantitatively. In EMU DE_Ems, a recruitment time series based on commercial catches at Herbrum (EmsG) ended in 2001. Today, recruitment into DE_Ems is assessed at two stations (EmsBGY since 2013 and EmsHG since 2014). In EMU DE_Elbe, elver monitoring takes place since 2003 at a station 230 km upstream (DoElY). Further monitoring activities have been started in EMU_Rhin, which are, however, so far not considered “time series”.

6.2 Yellow eel abundance surveys

Since 2003, an elver monitoring takes place in river Elbe (DoFpY) at 224 km distance from the sea. A special fyke net operates 2-4 days per week from May to October. The estimate is a projection of total catch (nr) based on monthly mean CPUE.

Based on a 15 year long commercial logbook data series (2004-2018), the development of the CPUE rate was investigated in the coastal waters of Mecklenburg – Western Pomerania. The monthly average CPUE data of two different passive gears (fyke net chains and stationary trap nets) and two yellow eel size classes (undersized <50 cm and legal size ≥50 cm) were analyzed. A change-point-analysis indicated that for undersized and legal sized yellow eels the CPUE rate increased significantly after 2015/2016 (Dorow et al. 2021).

Using a fishery independent enclosure system (Ubl & Dorow 2015), the yellow eel density in the coastal waters of Mecklenburg-Western Pomerania is monitored since 2009. Based on the monitoring data 2009-2020 an increased yellow eel density was detected (Dorow et al. 2023). Regarding the coastal waters of Mecklenburg-Western Pomerania, three data series (annual commercial landing data, CPUE data and enclosure data) indicate independently from each other an increased yellow eel stock in recent years.

6.3 Silver eel escapement surveys

In Warnow River a stow net (10 mm mesh size) is operating from March/April to December/January at a distance of 17 km to the Baltic Sea. The efficiency of the stow net for silver eel was repeatedly evaluated (mean: 11.1%) and the yearly estimate is a Petersen-Lincoln projection of total escapement (nr). The Warnow River eel stock is considered to consist of >90% eels from stocked origin (Frankowski et al. 2018).

In the Weser, a targeted fishery for silver eels is conducted by commercial fisheries with the aim of transporting as many of the migrating silver eels as possible to nearshore waters, from which they can migrate unhindered (Trap & Transport).

Between 2020 and 2022 total silver eel escapement was assessed in the River Ems by a mark recapture study (BALANCE-Project). The results of the study showed that the actual silver eel escapement from the EMU Ems is much lower than expected based on model results (GEM IIIc). This is partly caused by quality issues of the input data used for modelling, but the consistent tendency towards an overestimation of silver eel escapement in GEM validation studies indicates that also inadequate assumptions in the model structure could be responsible for producing too optimistic escapement values in German eel management.

6.4 Biological parameters

In the European Commission’s Data Collection Framework (DCF), morphometric and age data on eel from all EMUs are regularly assessed (depending on end-user need).

6.5 Parasites & Pathogens

The results of a German EMFF monitoring and restocking project (2015-2021), which investigated health status of different eel stages (elvers, yellow eel and silver eel) from North Rhine-Westphalian rivers, showed no bacterial infections, but frequently infections with *A. crassus* and/ or viral infections (Danne et al. 2022a). For more details, see German Country Report 2020 and 2021. The same project, and a new EMFF project (2022, 2023) aimed to investigate viral infections in batches of eels intended for restocking. Samples of glass eels from certified fisheries and farmed European eels from different aquaculture farms were analyzed. Via a combination of cell culture and qPCR-based techniques, infections of glass eels with the rhabdovirus eel virus European X and anguillid herpes virus 1 infections in farmed eels were detected (Danne et al. 2022a, Danne et al. 2022b). The results of the projects show that the conventional approach was not suitable for purchasing virus-free animals. From a biosafety perspective catch, trade and transport appear to be problematic.

Using a 30-year long data series (1990-2020) for coastal and inland waters generated in the federal state Mecklenburg – Western Pomerania, the infection history of *Anguillicola crassus* was investigated. Generally, decreasing trends regarding the prevalence rate as well as the average number of *A. crassus* in the infected eels were observed for coastal and inland waters in recent years (Unger et al. 2024).

Simon et al. (2023) investigated the infection of *A. crassus* and the associated impact on the individual growth of eels in the coastal waters of Mecklenburg-Western Pomerania.

Using a logbook study combined with a camera documentation, the frequency and degree of damage to eels caused by cormorants was investigated (Dorow et al. 2024).

7 New Information

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Dorow, M., Lill, D., Kühn, C., Frankowski, J. & Simon, J. (2024) Kormoranbedingte Schädigung von Aalen im Binnen- und Küstenbereich Mecklenburg-Vorpommerns. Fischer & Teichwirt 75: 340-344.

Fladung, E. (2023). Entwicklung und Bewirtschaftung des Aalbestandes (*Anguilla anguilla*) in Deutschland. Fischer & Angler Sachsen 1, 22 – 25.

Fladung, E., Baer, J., Camara, K., Czypionka, T., Diekmann, M. Dorow, M. & Frankowski, J. (2023). Positionspapier der federführenden Bearbeiter für die Managementpläne in den deutschen Aaleinzugsgebieten und Mitglieder der deutschen Aalarbeitsgruppe. Fischer & Teichwirt 74 (6), 210-213

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