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

Portugal

2018

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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Acknowledgments:

Capitania do Porto de Caminha

DGRM (General Directorate of Natural Resources, Maritime Safety and Services)

ICNF (Institute of Conservation of Nature and Forests)

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1 Stock status summary

In this section the stock indicators are compiled. The pristine escapement estimates (Table 1.1) have been improved compared to the estimates reported presented in 2008 for the Portuguese EMP (PT_Port EMU).

Data presented in the tables submitted for the ICES Data Call 2018 have been used in the Progress report 2018 for the European Commission, in accordance with Article 9 of the Eel Regulation - Regulation (EC) Nº 1100/2007.

Table 1.1. Stock indicators for the two Portuguese EMUs, PT_Port and ES_Minh according to the 2018 post evaluation reports

EMU_code	Assessed Area (ha)	B_0 (kg)	B_{curr} (kg)	B_{best} (kg)	B_{curr}/B_0 (%)	∑F	∑H	∑A
PT_Port	135487	1364571	698826	1026094	51.21	0.38	0.00	0.38
ES_Minh	1823,69	36474	4278	36474	11.7	2.73	0.00	2.73

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)

2 Overview of the stock and its management

2.1 Describe the eel stock and its management

2.1.1 EMUs, EMPs

In compliance with Regulation EC 1100/2007, Portugal has considered **two EMUs** in accordance with Article 2 of the Eel Regulation: one that includes the entire territory (mainland), and the other that includes the International River Minho. Therefore, Portugal submitted **2 EMPs**: one **national EMP** and a **transboundary EMP**, shared with Spain, for the River Minho.

The Portuguese Eel Management Plan was submitted in December 2008. This EMP was approved by the European Commission on the 5th April 2011, following the delivery of the last revised version on the 19th November 2010.

Despite the existence of 5 river basins extending beyond Portugal (Minho, Lima, Douro, Tagus, and Guadiana) (Figure 2.1a), and included in three different River Basin Districts (Figure 2.1b), it was agreed between both countries that the only Transboundary Eel Management Plan that should be considered was for River Minho, as it is the only international river where the river mouth is shared by both countries and there is a strong interest on the glass eel fishing. As

coordination between the two countries was delayed, it was not possible to consider it in December 2008, when submitting the Portuguese Eel Management Plan.

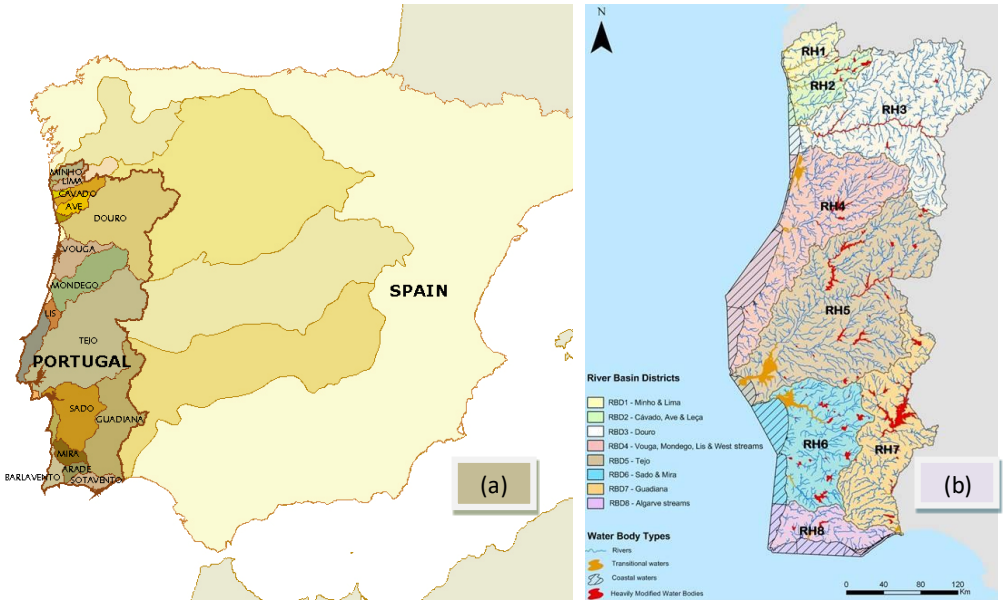


Figure 2.1. Map showing Portuguese River basins including the catchment area extending to Spain (a), and limits of the 8 Portuguese River Basin Districts defined according to the Directive 2000/60/EC (b). RBD is labeled as RH in the map.

A first version of the Transboundary EMP, for River Minho, was sent to the European Commission in June 2011 followed by a revised version in November of the same year. The Transboundary EMP was approved by the European Commission on the 21st May 2012.

Because the EMP for the River Minho was not delivered in time, Portugal had to reduce the fisheries effort until the implementation of the EMP in that river. Hence, several measures were taken to comply with the provisions of Article 4, number 4 *i.e.* to reduce fishing effort by at least 50 % relative to the average effort deployed from 2004 to 2006. Those measures included reducing the number of fishing licenses to fish glass eels, shrinking the authorized fishing zone for glass eels, shortening the fishing period, and banning the fishery for eels.

2.1.2 Management authorities

Eel fishery is managed by **DGRM** (General Directorate of Natural Resources, Maritime Safety and Services) with responsibility in coastal waters, and **ICNF** (Institute of Conservation of Nature and Forests) with responsibility in inland waters. These institutions are under two ministries: Ministry of Sea and Ministry of Agriculture, Forestry and Rural Development respectively. The exception is River Minho because as an international river having a common stretch bordering both countries, there is a Commission (**Standing Transboundary Commission of the River Minho**) that includes representatives from both countries setting specific rules that are applied to the fishery conducted in the international section of that river basin. Licenses to fish in inland waters are issued by ICNF, whereas licenses to fish in transitional and coastal waters are issued by DGRM. **Capitania do Porto de Caminha** issues licenses for the Portuguese part of River Minho.

The management of water bodies is the responsibility of **APA** (Portuguese Environment Agency) and 5 regional administration authorities for inland waters, which are under the Ministry of Environment. These authorities are responsible for the implementation of Water Framework Directive and therefore for obstacles in water basins.

Finally, ICNF is also the **National Authority for the CITES** convention, which implies they also have a role in the implementation of the EMPs.

2.1.3 Fishery Regulations

Glass eel fishery is forbidden in all river basins since 2000 (*Decreto Regulamentar* nº 7/2000), except for the international River Minho where it is still permitted (*Decreto Lei nº 316, artº 55 of 26/11/81*).

Yellow eel fishery is ruled by 11 specific byelaws applied to 11 fishing areas in coastal waters (estuaries and coastal lagoons) and 9 other byelaws that are applied to specific fishing areas called ZPPs (Zonas de Pesca Profissional / Professional Fishing Zones) (See Figure 2.2a), which are the only areas where professional eel fishery is allowed in inland waters. These laws set the rules for types and characteristics of fishing gears and in most cases, limit the maximum number of gears per fishing licence. Fishing effort is not recorded. In inland waters, professional fishery is ruled by Law 112/2017 (6 September, 2017) in the stretches represented in green, whereas in the sections represented in yellow it is ruled by the byelaws (Figure 2.2b).

Fisheries managed by DGRM have mandatory landing reports because eels are sold at fish auction, while in inland waters, there are no auctions. In 2012, in line with the implementation of the EMP, professional fishermen have become obliged to report catches annually to be able to renew their fishing licenses. Minimum legal size is 22 cm in both areas of jurisdiction. The yellow fishery is permitted from January 1st until September 30th.

It is forbidden to catch **silver eels**, which implies it is mandatory to release them if they are caught. Besides, a closed season of three months (October, November and December) has been set to increase escapement of silver eels. This prohibition was first set in 2010 for waters within the jurisdiction of DGRM, *i.e.* estuaries and coastal lagoons (*Portaria nº 928/2010, from 20 September*) and in 2012 for waters under the jurisdiction of ICNF, *i.e.* inland waters (*Portaria nº 180/2012, from 6th June*). In River Minho the yellow and silver eel fishery is forbidden since fishing season 2011-2012.

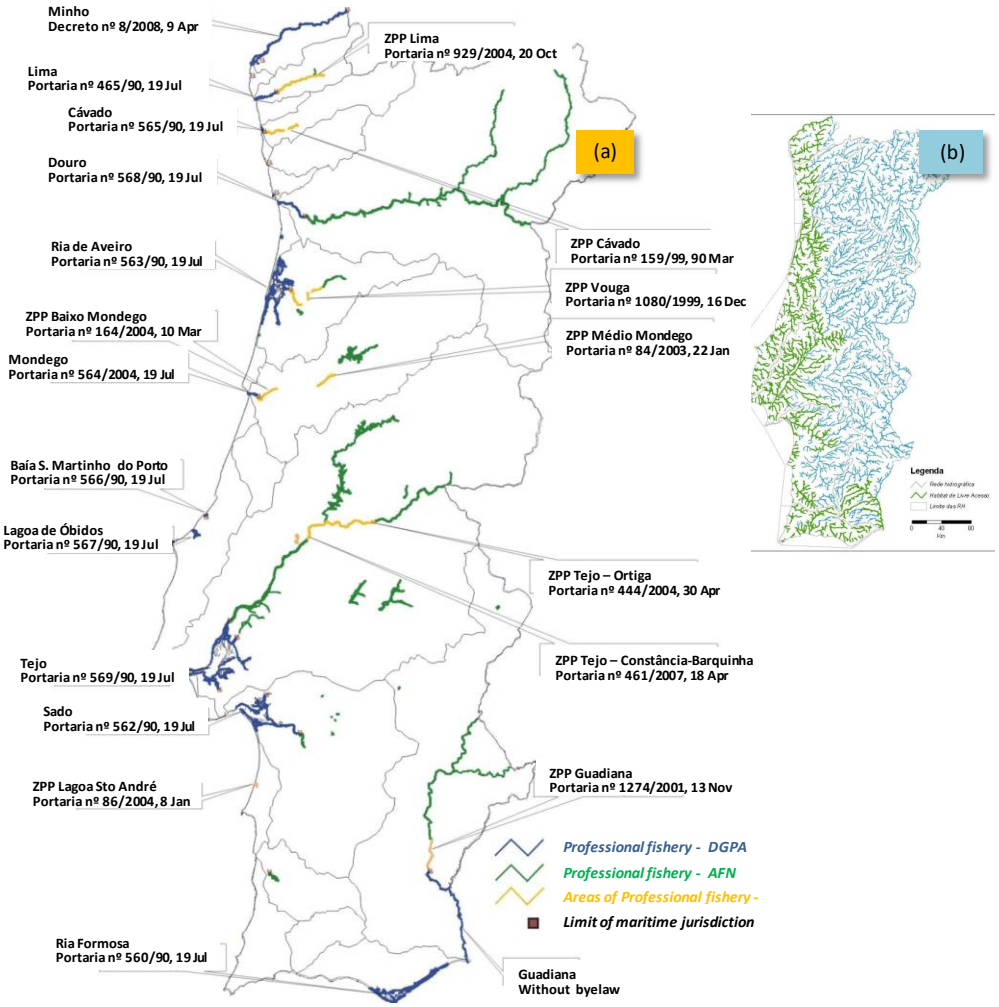


Figure 2.2. Map showing areas where professional fisheries can be conducted both in estuaries and coastal lagoons (jurisdiction of DGRM) and in inland waters (jurisdiction of ICNF) (a). The limit of maritime jurisdiction and the byelaws that rule the fisheries at each area are presented in the map (a). (Source: ICNF). The habitat that is accessible for the eel is also represented in green (b).

2.1.4 Management actions

The main objective of the Portuguese Eel Management Plan, which considered the entire country as one management unit, was to establish a series of measures to be applied at the national level that could contribute to reduce mortality and increase silver eel escapement as requested by Regulation 1100/2007. These measures can be classified into 4 categories:

- Fisheries restrictions
- Mitigation of obstacles to upstream migration
- Reinforcing police control on glass eel poaching
- Data collection (Habitat/stock assessment)

An overview of the measures foreseen can be seen in Table 2.1. In general, all measures related to the fisheries have now been implemented. These measures focused on reducing the fishing capacity and effort but also on setting a ban on the fishery during the most intensive period of

silver eel migration. Besides, to control the eel fishery in freshwater and reduce fishing effort, if needed, a special license for the eel fishery was implemented in 2018, under the designation of species of relevant interest for the professional fishery.

Table 2.1. List of the management measures foreseen within the scope of the Portuguese EMP and state of implementation. ☺ - Fully implemented; 😐 - Partially implemented.

ACTION TYPE	ACTION	LIFE STAGE	PLANNED	OUTCOME
Com. Fish	Prohibit the eel fishery outside the professional fishing areas in freshwater jurisdiction	Y	After 2011	☺
	Set maximum number of fishing gears and licenses per professional fishing area, in freshwater	Y	After 2011	☺
	Introduce obligation to report catches in freshwater to obtain a licence the following year	Y	After 2011	☺
	Introduce a specific annual license for eel fishery in freshwater jurisdiction	Y	After 2011	☺
	Introduce closed fishing season (1st October to 31st December) in freshwater jurisdiction	S	After 2011	Portaria nº 180/2012 ☺
	Introduce closed fishing season (1st October to 31st December) in marine jurisdiction	S	until 2012	Portaria nº 928/2010 ☺
	Reduce the number of licenses for marine water jurisdiction	Y	2009-	☺
Rec. Fish	Prohibit recreational eel fishery in marine (M) jurisdiction	Y/S	After 2011	Portaria nº 14/2014 ☺
	Prohibit recreational eel fishery in freshwater (F) jurisdiction		After 2011	Portaria nº 108/2018 ☺
Hydropower & Pumps	Mitigate the impact of existing obstacles (upstream migration)	G/Y	After 2011	😐
Restocking	0	na	na	na
Other	Collect data and conduct studies on the stock (Recruitment/Production/Escapement)	All	Until 2012	DCF 2017-2019 ☺
	Monitoring and control of glass eel poaching	G	2009-	☺

The reinforcement of the actions to reduce the poaching was carried out when the Portuguese EMP was approved, occurring in the aquatic systems during the fishery but also in land when catches are being transported. Several actions have been undertaken by the authorities both in the marine jurisdiction (Maritime Police) and freshwater jurisdiction (SEPNA, a special unit from GNR, the National Republican Guard). These authorities have been making a huge effort to control the situation, however the nets seized are rapidly substituted by new ones. SEPNA has among other competences, the obligation to monitor the illegal activities of fishing and can act on land. However, another special unit from GNR, the UCC acts close to the coast and has also been involved in these actions.

More recently, in 2017 and 2018, with the pressure on international illegal trade generated by the listing of *Anguilla anguilla* in CITES, the Portuguese Food and Economic Security Authority (ASAE) together with the CITES authority have been involved in joint actions that resulted in the seizure of glass eels at several Portuguese airports, on various occasions. Cooperation with the Spanish authorities, Europol and Interpol, have also been improved within

the scope of the illegal trade on glass eels. The Sargasso operation, which ended in March 2018, resulted in the seizure of 600 kg of glass eels as well as all the material used for storage and transport. (Press release from ASAE in http://www.asae.gov.pt/espaco-publico/noticias/comunicados-de-imprensa/asae-faz-a-maior-apreensao-de-meixao-de-sempre-em-portugal-e-desmantela-rede-de-trafico-de-meixao.aspx**).**

The most difficult measures to implement are related to restoring longitudinal connectivity for fish migration and the collection of data on the stock because they both require high funding. In the first case, an extra difficulty is added because there are numerous obstacles and their impact has not been evaluated. As for the need to collect data on the stock (recruitment/production and escapement), vital to accomplish the objectives set by the Eel Regulation, it was finally started in 2017, under the EU MAP obligations.

The implementation of the Transboundary EMP for the River Minho has been more successful, mostly because it includes a smaller area and the measures were all focused on the fishing activity, which is easier to implement. The results can be consulted in table 2.2.

Table 2.2. List of the management measures foreseen within the scope of the Transboundary Eel Management Plan for the River Minho and state of implementation. ☺ - Fully implemented.

ACTION TYPE	ACTION	LIFE STAGE	PLANNED	OUTCOME
Com Fish	Prohibit the eel fishery	Y/S	EMP	☺
	Reduce fishing effort	G	EMP	☺
	Introduce obligation to fill in logbooks	G	After approval	☺
Rec Fish	Prohibit the eel fishery in marine jurisdiction	Y/S	EMP	☺
Hydropower & Pumps	0	na	na	na
Restocking	0	na	na	na
Other	0	na	na	na

2.2 Significant changes since last report

The stock indicators have been provided for the first time both for the ICES data call 2018 and the 2018 EMPs Progress Reports.

The collection of information about the stock as well as biological sampling are being conducted since 2017, within the framework of DCF, following the Commission Implementing Decision (EU) 2016/1251 - Multiannual Programme for the collection, management and use of data in the fisheries and aquaculture sectors for the period 2017-2019.

3 Impacts on the stock

3.1 Fisheries

3.1.1 Glass eel fisheries

The glass eel fishery is prohibited in all rivers of Portugal (*Decreto Regulamentar* nº 7/2000 of May 30), except for River Minho (Decreto-Lei 316 artº 55 of 26/11/81). It was after the fishing

season 2000/2001 that the fishery became prohibited in all other Portuguese rivers, except for aquaculture and restocking programmes. The official fishery statistics from Minho are kept by the responsible local Authority – Capitania do Porto de Caminha. Total annual statistics have been recorded since 1974 (Figure 3.1).

Glass eel fishery in the River Minho was permitted between November and April for many years, but after the fishing season 2005/06, mostly due to the eel population decline and the high fishing pressure, an agreement between the Portuguese and Spanish authorities, has been gradually reducing the fishing period. The fishing season is currently defined, to include four New Moons (the most profitable period). In the last fishing season (2017/18) fishing occurred between the November and the February.

To reduce fishing pressure, it was decided by the Standing Transboundary Commission of the River Minho that starting on the fishing season 2010/2011 the maximum number of fishing licenses for each country would be 200, and that the fishing zone for glass eels would decrease 25 km in the river length. In the same year a new change was introduced in the licensing process, as licenses started to be issued to the owners of the boats and not to fishermen, implying that the drop to 126 licenses in 2011 is a consequence of these changes rather than a real reduction in fishing pressure. The number of fishermen is however, generally the same, as there are two men per boat.

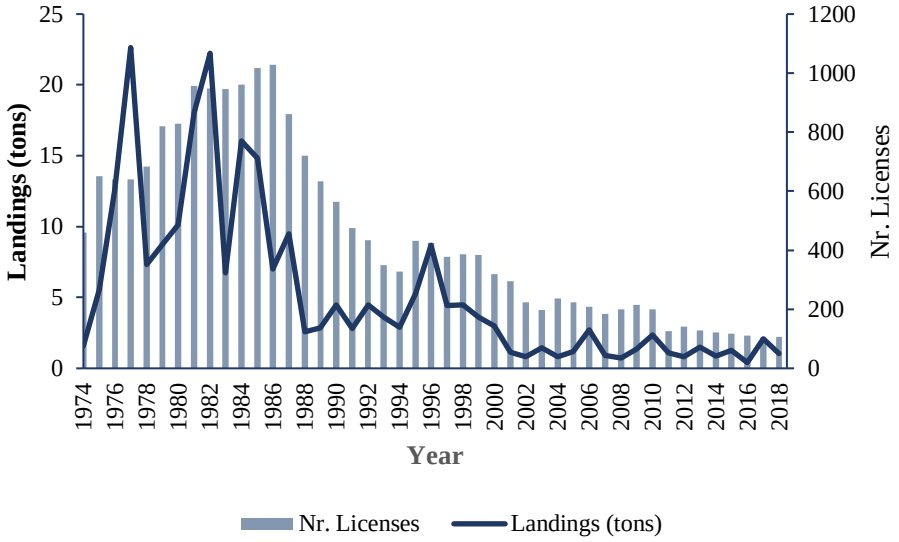


Figure 3.1. Glass eel recruitment and number of licenses issued in the River Minho 1974 to 2018 (Source: Capitania do Porto de Caminha).

Following the implementation of the Transboundary EMP for the Minho, a change in reporting catches has been introduced since the fishing season 2011/2012. Fishermen who do not report catches of glass eels, are not issued a fishing licence the following year. In addition, fishermen are obliged to report their catches monthly to local authorities and to keep a logbook where they record the quantity of glass eels caught in each fishing session. If the difference between data registered in the logbooks and what is sold in the auction is higher than 250g, licenses will not be renewed. A quota of 3kg of glass eels per fisherman per day was established from 2016 on.

3.1.2 Yellow eel fisheries

Fishing capacity in freshwater is not known, and under the present legislation it is not possible to estimate the number of fishermen and eel fishing gears they owe/use. Professional fishermen must obtain a licence issued by ICNF to fish in these waters and they are obliged to report their catches. The professional fishery is ruled by 9 byelaws, which define the river sections where fishermen can fish, establish the number of fishermen for each fishing season and the rules for fishing (fishing gears and mesh size, size limit of the species, hour restrictions and species restriction).

The fishing licenses issued by DGRM for local fishery in estuarine and coastal waters are linked to fishing boats. The same fishing boat can be licensed to fish with more than one type of fishing gear. In some areas within the DGRM jurisdiction, there is a policy on maximum number of fishing gears permitted by licence. That does not imply fishermen use them all, but the number they use is unknown. The type, number and characteristics of eel fishing gears vary according to fishing area. There are 11 specific byelaws that set the rules for 11 fishing areas. However, for certain areas and/or fishing gears there is no restriction on the number permitted for each licence. These different rules and the lack of record on the actual number of fishing gears fishermen use, contribute as extra difficulties to estimate fishing capacity.

The use of fyke nets in the River Minho was banned by Decree 8/2008 (April 9th) and its application started on the fishing season 2008/2009. However, longlines are still permitted in the international part of the river (80 Km) and eels are caught as bycatch (maximum 10% allowed) of other fisheries.

Landings from coastal fisheries (estuaries and coastal lagoons) are shown in Table 3.2. There was a decline in catches after 2010, which continues today. However, it should be noted that a ban of three months (October, November and December), implemented in 2010 (Portaria nº 928/2010, from 20 September), might account for the decline observed. The changes in fishery regulations, derived from the implementation of the EMP, add as extra difficulties to evaluate the trend on the stock, based on landings.

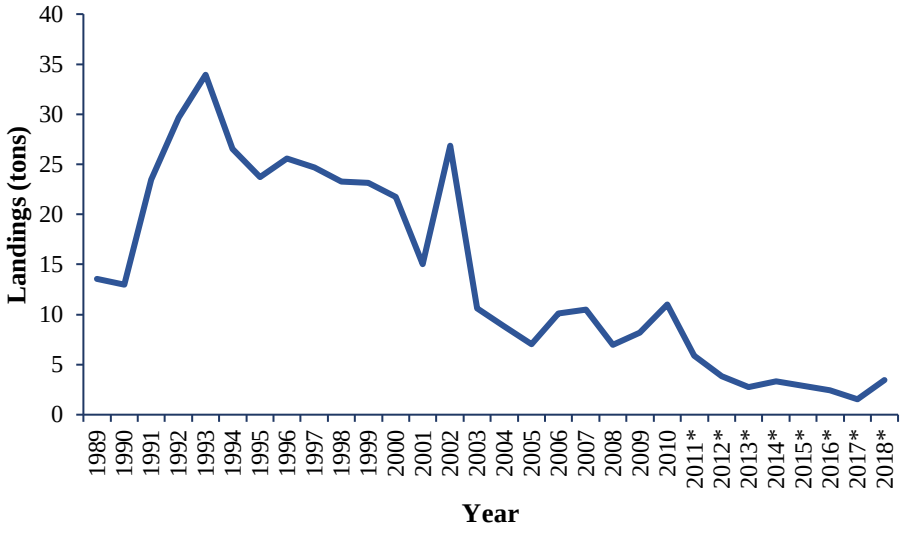


Figure 3.2. Annual landings of yellow eel fishery in coastal waters (estuaries and coastal lagoons), from 1989 to 2018. Data for 2018 are provisional (Source: DGRM). (*) An eel fishing ban was set between October and December, starting in 2011, to increase silver eel escapement.

Recreational fisheries have become forbidden for the eel. Following the measures established in the two EMPs, it is forbidden to catch eels by recreational fishery since 2010 in River Minho, since 2014 (Portaria nº 14/2014 from 23rd January) within the marine jurisdiction, i.e., in transitional waters and since April 2018 within the freshwater jurisdiction (Portaria nº 108 from 20th April).

3.1.3 Silver eel fisheries

It is forbidden to fish silver eels. With the implementation of the EMP, the eel fishery was closed during the most important period of spawning migration, *i.e.*, from the 1st October to 31st December in both marine (Portaria nº 928/2010) and freshwater (Portaria nº 180/2012) jurisdictions. Besides, in the freshwater jurisdiction, if fishermen catch silver eels outside the ban period, they are obliged to return them to the water.

3.2 Restocking

There is no stocking of eels in Portugal.

3.3 Aquaculture

Aquaculture production of European eel is not significant in Portugal because there have been no units of eel aquaculture in Portugal. In brackish water systems, production of eels is a by-product in aquaculture systems directed towards extensive and semi-intensive seabass (*Dicentrarchus labrax*) and seabream (*Sparus aurata*) farming. The production of eels in these systems is presented in Table 3.1.

Table 3.1. Aquaculture production of eels (tons) between 1997 and 2016 (Source: DGRM)

YEAR	PRODUCTION (TONS)
1997	16.2
1998	13.2
1999	3
2000	6
2001	6.5
2002	4.2
2003	4.7
2004	1.5
2005	1.4
2006	1.1
2007	0.5
2008	0.4
2009	1.1
2010	0.3
2011	0.6
2012	0.9
2013	1.4
2014	0.9
2015	0.9
2016	1.1

A new aquaculture unit for eel production has however, been installed in central Portugal (Figueira da Foz), but it is not yet producing. It is expected to produce 500 tons per year.

3.4 Entrainment

Anthropogenic impacts identified in the two Portuguese Eel Management Plans (PT EMU and PT Minho EMU) were mainly related to fisheries and obstacles to migration that have reduced available habitat to grow. Although turbine activity is usually a major mortality factor especially for silver eels, in Portugal there is no passage for eels in the hydroelectric dams, which implies there is no mortality associated with turbines. Besides, because these EMPs do not include stocking of upriver sections that are inaccessible for the eel, there is not a problem for silver eels escaping from continental waters to spawn. As for pumps or diversions, they may become a problem especially for glass eels that might easily be entrained by the pumps, but that impact has not been considered and is not being assessed.

3.5 Habitat Quantity and Quality

Habitat quality and quantity have been considered in the Portuguese EMP as measures to increase the quality and quantity of silver eels escaping to the sea. The improvement of water quality was a measure set in the Portuguese EMP to be achieved by the implementation of WFD. However, because there are many obstacles in the water courses, the quantity of habitat available for eels to grow, required a list of needs to be implemented in the short, medium and long run.

The quantity of habitat free of obstacles has also increased in River Mondego. A project entitled "Rehabilitation of habitats for diadromous fish in the River Mondego" funded by Programa Operacional Pesca 2007-2013 (PROMAR) (Reference 31-03-02-FEP-5), which aimed to remove obstacles allowed to install an eel pass in the first dam that was hampering the colonization of the watershed. The result was an effective increase of 30 km of river completely free of obstacles. The monitoring of the eel pass is under course.

In River Minho, the presence of the Frieira dam impedes eels from migrating upstream. As such, there is a high concentration of juvenile eels (elvers) just below this obstacle, which has driven the authorities to release these individuals in tributaries located below the dam to reduce mortality derived from high densities. In total there was a redistribution of 3.7 tonnes of eels between 2011 and 2017 (Table 3.2).

Table 3.2. Quantity of eels (kg) captured below the Frieira dam both in the salmonid ladder and the ramp. (Source: Estación de Frieira dam)

YEAR	Ramp	Ladder	Total
2011	187.52		187.52
2012	243.18		243.18
2013	98.86	658.45	757.31
2014	136.01	426.65	562.66
2015	103.75	652.3	756.05
2016	70.76	104.28	175.05
2017	82.7	915.44	998.145
TOTAL	922,78	2757,12	3679,915

An ongoing project (LIFE16 ENV/PT/000411) entitled "Conservation and management actions for migratory fish in the Vouga river basin" aims to improve habitat accessibility for migratory species. The European eel will also benefit from this project that will end in 2022 (1st Aug 2017 to 31st Jul 2022).

3.6 Others

Nothing to report.

4 National stock assessment

4.1 Description of Method

4.1.1 Data collection

Surveys are currently done under the DCF (Period 2017-2019). A combination of methods including the commercial fishery and independent surveys are used as a proxy to estimate stock indicators. Wherever there is a fishery, it is monitored, but in the absence of a fishery, experimental fishing is carried out.

The river basin chosen to represent the PT_Port EMU was River Mondego (estuary and freshwater) to compare with data from the 1990s but because this EMU is the whole country and the production of eels is affected by the type of aquatic system, a coastal lagoon (Santo André Lagoon) was also included in the data collection to represent the variety of aquatic systems (river + estuary + coastal lagoon). These surveys include experimental fishing for recruitment estimates (monthly from November to April) and surveys on yellow and silver eels in the Mondego river. Moreover, still within the framework of DFC biological sampling is also being conducted. A sample of eels is collected each year for length, weight, sex and age determination.

As for the other EMU, ES_Minh, the same surveys and biological sampling are being conducted under DCF. The yellow eel fishery is prohibited, which implies biological sampling is done by experimental fishing.

4.1.2 Analysis

Estimates of the silver eel biomass were improved compared to the estimated biomass provided in the Portuguese EMP presented in 2008, in which calculations were done by extrapolating data from watersheds of France. The biomass estimates herein presented are based on the densities of yellow eel surveys conducted in the Mondego river, using electric fishing. Additionally, sampling of yellow and silver eels that has been conducted between 2014 and 2016 within the framework of the Project "Rehabilitation of habitats for diadromous fish in the River Mondego" funded by PROMAR, provided data to determine the mean silvering age, the mean weight (yellow and silver eels), and the silvering rate. Data from scientific surveys conducted in 1988-90 (Domingos unpublished data) was used to improve estimates of the pristine biomass of silver eels.

The stock indicators were calculated for the PT_Port EMU, extrapolating the silver eel production obtained in the river Mondego, according to the following expressions:

B_0 = [[(YE densities 1988)*(silvering rate)]*mean SE weight] * wetted area

$B_{current}$ = [[(YE densities 2017)*(silvering rate)]*mean SE weight] * wetted area

B_{best} = $B_{current}$ + Anthropogenic mortality in Silver Eel Equivalents (SEE)

The silvering rate and mean silver eel weight were obtained by conducting surveys in the river Mondego during the Autumn period when silver eels can be distinguished morphologically. The silvering rate was estimated calculating the ratio between these individuals and the non-migrating ones (Durif *et al.*, 2009), being 2.8%, and the mean weight considered was 109g.

The wetted area is the natural habitat of eel in the PT_Port EMU, which was considered unchanged since 1988, because all the anthropogenic obstacles present in 2017 already existed in 1988. Therefore, the pristine habitat (referred to the period 1988) in the EMU is the same as the current habitat and amounts to a total of 135487ha (see table 1.1).

The anthropogenic mortality in SEE was calculated using the method proposed by the WGEEL and considering a five-year generation time, based on the age determined for silver eels from the Mondego. The catches of glass and yellow eel (silver eel fishery is forbidden), from five and three years ago, respectively, were used, and an 80% mortality in glass eel settlement and annual mortality of 0.138 were considered (Dekker, 2000); we assumed yellow eel average weight of 23.6g and silver eel average weight of 109.0g (Table 4.1).

Since glass eel catches are forbidden in the PT_Port EMU, the catches from the Minho river (fishery allowed) were used to estimate the illegal catches in the EMU by extrapolation. It was therefore considered that the main river basins (Lima, Cávado, Ave, Douro, Vouga, Mondego, Tejo, Sado, Mira, Guadiana) from the PT_Port EMU had the same amount of illegal fishing as the legal fishing that occurs in the Minho river, and the total of illegal catches estimated by this method was considered to represent illegal catches of glass eel throughout the whole EMU.

Table 4.1. Data used to estimate the anthropogenic mortality in SEE for the PT_Port EMU

Glass eel mean weight (g)	Yellow eel mean weight (g)	Silver eel mean weight (g)	Yellow eel mean age	Silver eel mean age	Glass eel settlement mortality	Eel natural mortality
0.28	23.6	109.0	3	5	80%	0.138

The only anthropogenic mortality considered was the mortality derived from the fisheries, which was estimated using the following expression:

SumF= -ln (Bcurrent/(Bcurrent+kg SEE)).

4.1.3 Reporting

The stock indicators are included in the 2018 EMPs progress reports (PT EMU and PT Minho EMU) to deliver to the EC, as required by the EU Eel Regulation (1100/2007).

The data, which started to be recently obtained in the frame of the DCF (period 2017-2019), is regularly reported to the EC, is used/included in the ICES data call and contributed to estimate the indicators and to improve the stock assessment.

4.1.4 Data quality issues and how they are being addressed

The following quality issues must be addressed in a near future:

• Anthropogenic mortality indices are still missing in the EMU, namely glass eel illegal fishing.

• Coastal waters were considered to have the same eel densities as the freshwater zone for the present estimated biomasses. DCF data from the Mondego estuary and Santo André coastal lagoon will be used to improve production estimates in estuaries and coastal lagoons all over the EMU.

• The silver eel biomass indicators represent the EMU total production and not the real silver eel escapement.

4.2 Assessment results

The assessment results are presented in chapter 1 and since those were the first stock indicators estimated since the delivery of the EMPs, it is not possible to report any changes over time.

5 Other data collection

Sampling of yellow and silver eels has been conducted between 2014 and 2016, within the framework of two Projects “Rehabilitation of habitats for diadromous fish in the River Mondego” and “Sustainable Management of the Eel Fisheries in Santo André Lagoon", both funded by PROMAR. Biological aspects to be studied included sex ratio, age, *Anguillicola crassus* infection, and silvering rate. Ecological aspects include size distribution, abundance, influence of obstacles and escapement.

In the River Minho, the project “Migra Miño-Minho”, funded by INTERREG – POCTEP (2017-2020), aims to improve river connectivity for diadromous species including the eel.

5.1 Recruitment time series

The recruitment time series that has been used by the WGEEL to analyse the trends in recruitment is the commercial fisheries from River Minho. There have been some changes in the number of licenses throughout time (Figure.3.1), as well as in the extension of the fishing season.

There are no other recruitment series, but within the framework of DCF two new series are being started: one in the Minho river and the other in the Mondego river. The choice of this river system aims to create the opportunity to compare present recruitment with data from late 80s, when recruitment started to decline.

5.2 Yellow eel abundance surveys

There have been surveys on yellow eels in the Mondego River and in Santo André Lagoon, under the framework of two projects funded by PROMAR. This data has contributed to improve

the quality of estimates of production in coastal lagoons and rivers presented in the EMP. These surveys continue within the framework of DCF.

5.3 Silver eel escapement surveys

Scientific surveys on silver eel escapement have been conducted within the scope of two projects funded by PROMAR: one in the River Mondego and the other in Santo André Lagoon. In both cases, receivers were installed in the aquatic systems studied along the water course until the river mouth (Mondego River) and in the coastal area close to the opening of the lagoon (Santo André Lagoon) to measure escapement. The results obtained for the Mondego River will be compared with new data from the SUDOANG project (SOE2/P5/E0617), funded by Interreg, in which acoustic transmitters will once again be used to measure real escapement aiming at calibrating a model for escapement in the SUDOE area.

5.4 Biological parameters

Biological parameters are being collected under DCF since 2017 according to the Commission Implementing Decision (EU) 2016/1251 of 12 July 2016 adopting a multiannual Union programme for the collection, management and use of data in the fisheries and aquaculture sectors for the period 2017-2019. River Mondego, River Minho and Santo André Lagoon were selected as representative of all type of habitats present in the PT_Port EMU, which comprises the entire country. River Minho has also been included to sample biological parameters from the other EMU.

In studies of eel age which have been conducted in Portugal, sagitta otoliths have been removed, cleaned with water, stored dry, and cleared in 70% alcohol (Vollestad, 1985) for 10 minutes before being examined under a stereoscope microscope. The otoliths were read by more than one person (Gordo & Jorge, 1991), or by the same person who read them twice (Costa, 1989; Domingos, 2003; Lopes 2013, Monteiro 2015). In the lack of agreement between both readings, a third reading was performed and if inconsistent, otoliths were excluded from analyses.

The same procedure is being followed for age reading. Silver stage is being identified according to Durif *et al*. (2009).

Stock assessment requires the collection of stock indicators to accomplish the goals set by the Eel Regulation (mortality and biomass indicators). A combination of methods including the commercial fishery and independent surveys are being used to estimate those indicators in both EMUs.

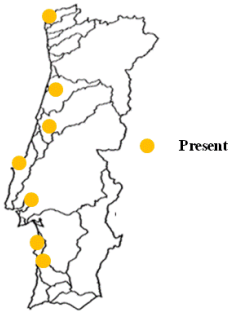
5.5 Parasites & Pathogens

There is not a national programme to monitor parasites or pathogens. *Anguillicola crassus* is however probably spread throughout the country. Despite not mandatory, the assessment of the infection by the parasite *Anguillicola crassus* is being carried out under DCF, but the results are not available yet. A summary of the infection analysed in previous years is presented below.

In a study conducted in 2008 in five brackish water systems (Aveiro Lagoon, Óbidos lagoon, Tagus estuary, Santo André Lagoon and Mira estuary) it was concluded that *A. crassus* was spread in all systems except in Óbidos lagoon, which was probably related to the higher salinity observed in this lagoon, similarly to what happens in one sampling site (Barreiro) (Neto *et al*., 2010) located in the lower part of the Tagus estuary. Prevalence values ranged from 0 to 100 %

and intensity values ranging from 0.4 to 5.8 (unpublished data). Within the DCF programme, the parasite was found in the swimbladder of 7 among the 404 eels examined for the Óbidos Lagoon in 2009. The low prevalence found (1.73%) reinforces the idea that the infection rate is very low in areas with higher salinity, as it is the case in this lagoon. The presence of the parasite had already been reported for the River Minho (Antunes, 1999) and River Mondego (Domingos, 2003), which suggests the parasite is probably widespread in Portugal. In River Minho, the presence of the parasite was reported for the entire international section of the river and prevalence ranged between 23% and 100% (Braga, 2011). The map shows the locations where this parasite has been reported so far.

River Minho
Aveiro Lagoon
River Mondego
Óbidos Lagoon
River Tagus
Santo André Lagoon
River Mira



5.6 Contaminants

No new data is available for 2018, as there is no routine sampling for contaminant analysis in eel. However, there is some information from previous years.

Samples of eels caught from five brackish water systems (Aveiro Lagoon, Óbidos Lagoon, Tagus estuary, Santo André Lagoon and Mira estuary), were analysed for some trace metals (Hg, PB, Zn, Cu, Cd) revealing low contamination loads when compared to their European congeners (Passos, 2008; Neto, 2008; Neto *et al.* 2011a). The most contaminated eels were obtained from the Tagus estuary. However, in this estuary no clear relationships could be established between contaminant concentrations in eel tissues (liver and muscle) and in sediment, probably because of the general heterogeneity in environmental conditions (Neto *et al.*, 2011b). In the River Minho, significant increases in the levels of metals (Zn, Pb and Cr) were found when comparing glass eels with muscle of yellow eels between 15 and 30 cm. However, the whole sample of yellow eels (muscle and liver) revealed low contamination levels (Braga, 2011).

A comparative study about the effects of pollution on glass and yellow eels from the estuaries of Minho, Lima and Douro rivers was developed by Gravato *et al.* (2010). Fulton condition index and several biomarkers indicated that eels from polluted estuaries showed a poorer health status than those from a reference estuary, and adverse effects became more pronounced after spending several years in polluted estuaries.

5.7 Predators

Apart from the fish species Lusitanian toadfish (*Halobatrachus didactylus*) that can predate on eels (Costa *et al.*, 2008) and the European eel, which can display cannibalistic behavior (Domingos *et al.*, 2006), the main predators of eels in Portuguese aquatic systems include the great cormorant, *Phalacrocorax carbo*, and the European otter, *Lutra lutra*. The eel is present in the diet of otters and cormorants throughout the year, but they become more important in

spring and summer when the water level is lower (Trigo 1994; Cerqueira 2005; Dias 2007). The impact of predation on the eel population is unknown but eels represented 25.4% of the diet of otters from Ria Formosa (Cerqueira, 2005), a shallow coastal lagoon, located in the south of the country, and 7% of the diet of cormorants from Minho estuary (Dias, 2007). The real impact of this predation on the eel stock in Portuguese waters is unknown, despite the increase in the population of the great cormorant and the European otter in recent years.

Data on eel predators is not being collected because this was not identified as a problem in the EMPs but also because it is considered natural mortality. However, a recent study conducted in Santo André Lagoon in 2015 under the project "Sustainable Management of the Eel Fisheries in Santo André Lagoon" funded by PROMAR, concluded that the importance of the eel in the diet of the great cormorant was very reduced contrary to what has been reported by other authors elsewhere (e.g. Ovegård *et al*., 2017).

6 New Information

Some work has been devoted to analyze recruitment of glass eels to Portuguese coastal waters. (Startoudakis *et al*., 2017; Correia *et al*., in press). The difference found between the recruitment trend observed in the Minho river (Correia *et al.* in press) and that reported by WGEEL for wider European geographical scales highlights the need to estimate recruitment indices with a higher geographic resolution to better support the assessment of the status of the European eel population.

A new glass eel recruitment series was established under DCF in the estuary of River Mondego, where data from the late 1980´s existed. The sampling method used is the same as in the past (tela) to guarantee comparability among data. Moreover, still under DCF, glass eel recruitment is also being monitored in the River Minho.

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