Guidelines for collecting biological data for the assessment of European eel (*Anguilla anguilla*) stock.

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Introduction

The Inland Waters and Fish Resources Survey Department of the Institute of Food Safety, Animal Health, and Environmental Science (BIOR) conducts research on eel resources in Latvian rivers and lakes, organizing monitoring surveys and collecting samples from commercial fishing catches along the coast. This document describes how and what biological information is collected.

Assessment of the eel stock

The assessment of the European eel stock is coordinated by the International Council for the Exploration of the Sea (ICES) across its distribution range. The assessment is carried out by the Joint ICES/EIFAAC/GFCM Working Group on Eel (WGEEL), with the participation of specialists from eel range countries and utilizing data prepared by these countries on natural stock recruitment, eel fishing, restocking, and research surveys.

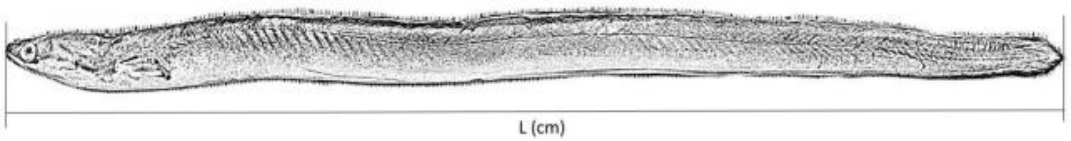
Data collection

3.1. Assessment of yellow eel production in rivers

The electrofishing method with a single pass is used to assess yellow eel density in rivers, using stationary or backpack-type direct current electrofishing equipment and conducting surveys in an area of 250-350 m². The surveys are conducted in rivers without upstream migration barriers. In lakes, at least 200 m long transects in shallow water zones are surveyed from a boat. The surveys are carried out according to the Latvian standard LVS EN 14011:2003 "Water quality - Sampling of fish with electricity," which is identical to the European standard EN 14011:2003 "Water quality - Sampling of fish with electricity," from mid-May to mid-September. The selection of the sampling site takes into account the depth, which affects the success of the surveys (optimal up to 70 cm), and in rivers, it is desirable to include at least part of the sampling site in riffle habitats. Examples of electrofishing protocols can be found in Appendices 1 and 2. The layout of long-term sampling sites is provided in Appendix 3.

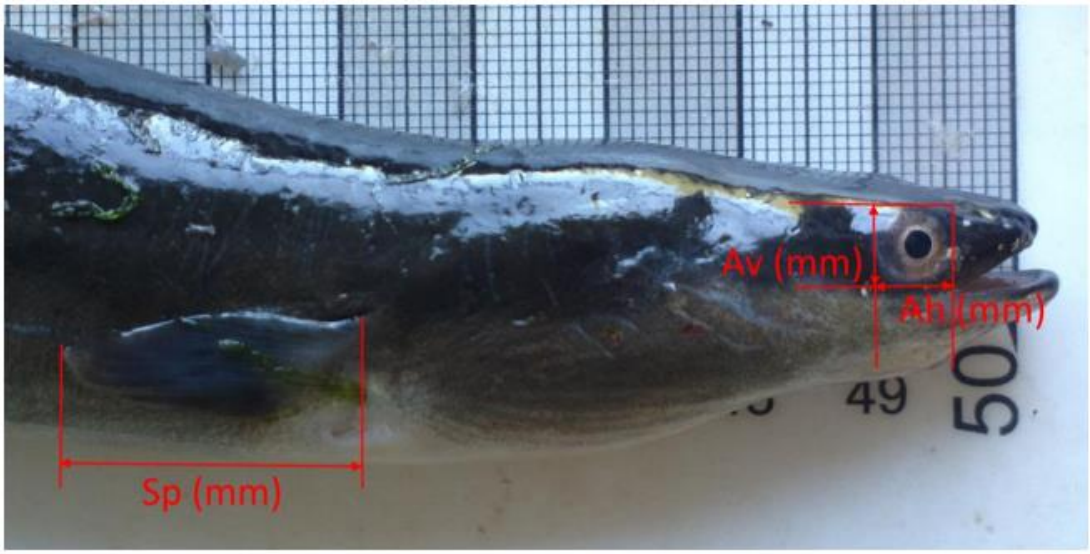
3.1.1. Biological measurements

All eels caught during electrofishing surveys are recorded, and body length measurements are taken to the nearest millimetre.



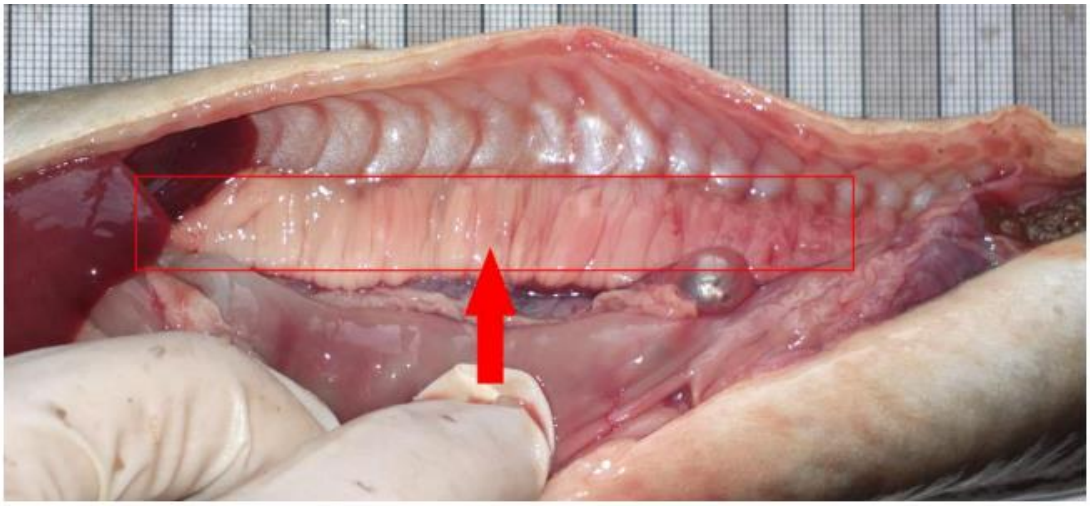
From each sampling site, two eels are collected for laboratory analysis from a specific size group. The following measurements are recorded for the collected eels: weight (g), average eye diameter (mm), and pectoral fin length (mm) using calipers (precision up to two decimal places). These parameters are used in the calculation of eel stages (Durif et al., 2009). Macroscopic examination includes assessing the stomach contents (identifying prey organisms to the lowest possible taxonomic level) and the level of *Anguillicola crassus* infection in the swim bladder.

Measurements of eye orbit diameter and pectoral fin length are taken.

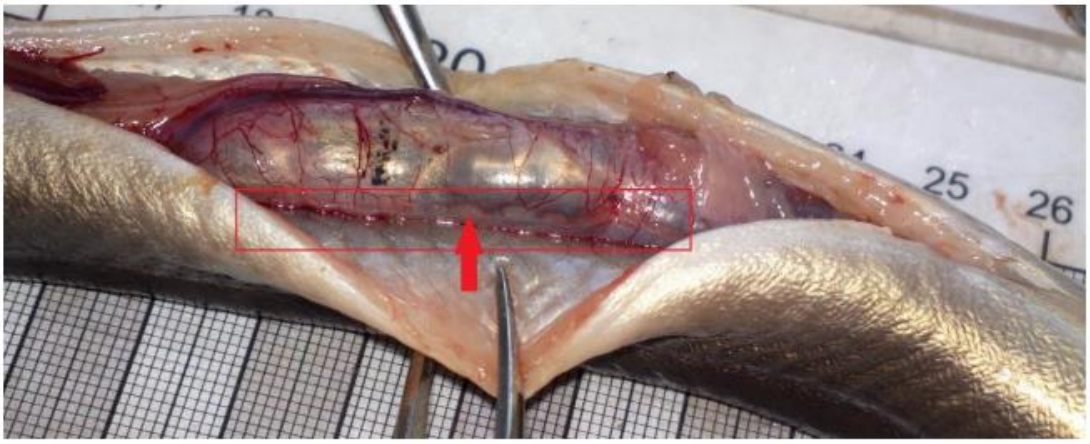


Gonad analysis is performed in the laboratory for gender determination.

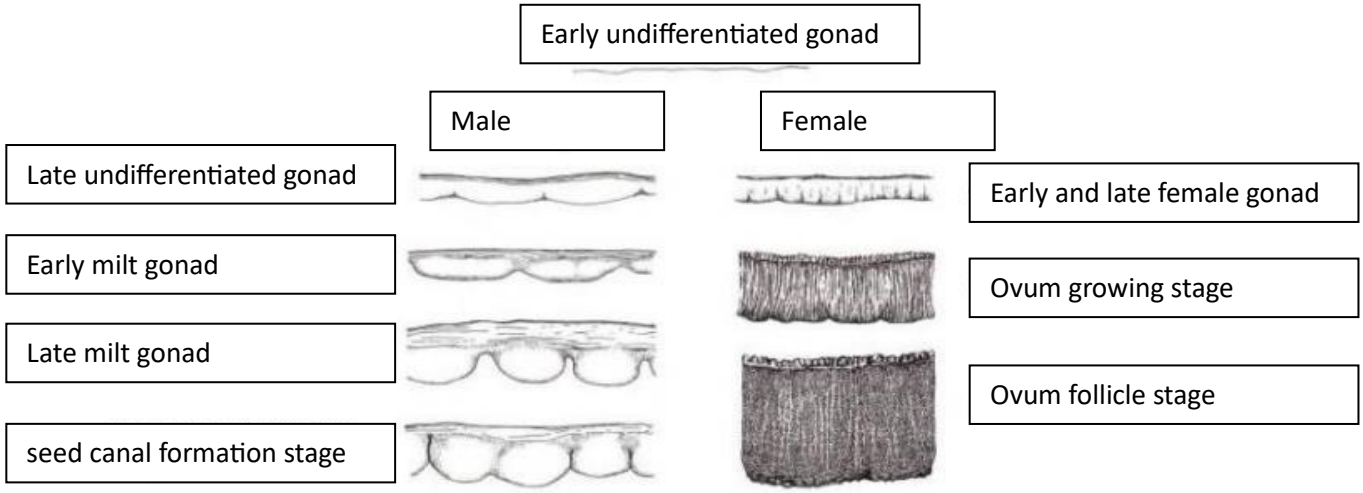
Female eel gonad



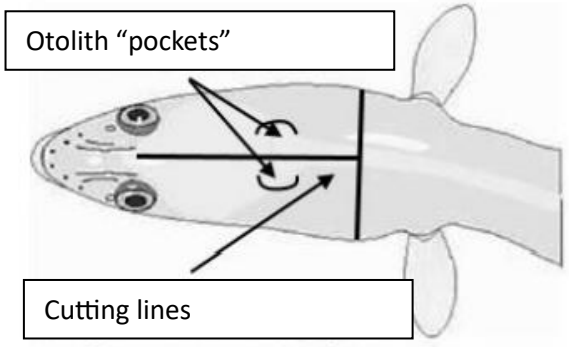
Male eel gonad

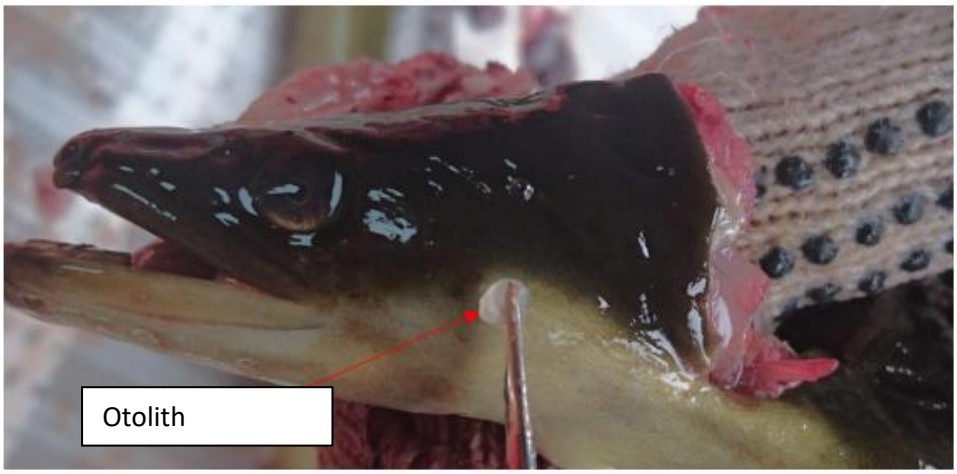


Eel gonad maturity stages



Otolith gathering, age determination





3.1.2. Calculation of Yellow Eel Density

The density of yellow eels is calculated using the coefficient p, which expresses the probability of the proportion of fish being captured in the first fishing attempt.

$$p = \frac{3A - T - \sqrt{T^2 + 6AT - 3T^2}}{2A},$$

$$T = c_1 + c_2 + c_3,$$

Where c1 is the number of individuals caught in the first sampling, c2 is the number of individuals caught in the second sampling, and c3 is the number of individuals caught in the third sampling.

$$A = 2c_1 + c_2,$$

The values of p are calculated from a combined sample where the survey results from sampling sites historically fished 3 times are summed. In the case of eels, the coefficient p is recalculated and equal to 1.

The formula for calculating the density of yellow eels per 100 m2 area is as follows:

$$N = \left(\frac{c_1}{1}\right) * \left(\frac{100}{U}\right),$$

where U represents the sampled area (m2).

3.1.3. Quality of Biological Data

Biological data is entered and summarized in Excel database format. The biological parameters have defined limits (minimum and maximum allowable values). Once the data is entered, an

analysis of eel length data is performed (independently reviewed by two researchers). If necessary, erroneous entries are corrected in the Excel database file and electrofishing protocol.

3.2. Assessment of Silver Eel Production for Sea Migration

For silver eel assessments, small fish weirs are used at the outlets of rivers from lakes or in river estuaries.

In the Daugava River estuary, from May to November, four small fish weirs (with eye size 8-10 mm) are installed for partial assessment of silver eels migrating to the sea. The total number of fishing days is recorded. All captured eels are held alive until marking and biological measurements are taken. Biological parameters are measured on all captured eels to determine the silvering stage (see Section 3.2 and Appendix 4). Additionally, all captured eels are marked with external Carlin or T-bar tags and released back into the river to assess mortality in different bycatch.

In the Lilaste River, a full assessment of downstream migrating eels is conducted from April to November by installing one small fish weir (with eye size 14-20 mm) across the width of the river. The total number of fishing days is recorded. All captured eels are held alive until marking and biological measurements are taken. Biological parameters are measured on all captured eels to determine the silvering stage (see Section 3.2). Additionally, all captured eels are marked with external Carlin or T-bar tags and released back into the river downstream from the weir to assess mortality in different bycatch.

The number of captured eels is related to the migration area of the Daugava and Lilaste Lake basins. The number of downstream migrating silver eels obtained from the sampling unit is further extrapolated to the total available area of inland waters in Latvia (23578 ha) where eel stocks are supplemented.

3.3. Data Collection for Fishing

For coastal fishing, fishing and biological data for 50 to 100 eels are collected (fishing location, fishing gear, date, eel length, weight, gender, average eye diameter, length of chest spurs, and presence of *Anguillicola crassus*). Additionally, otolith samples are collected from 50 eels for age determination.

3.3.1. Quality of Biological Data

Biological data is entered and summarized in Excel database format. The biological parameters have defined limits (minimum and maximum allowable values). Once data for eels is entered, an

analysis of length and weight data is performed. A linear regression model is created to determine the trend line and forecast confidence intervals. Entries outside the confidence intervals are flagged as erroneous and rechecked, and if necessary, corrected. Biological data is rechecked again during age determination. The age determiner compares the records for each individual eel with information in the otolith notebook and the database. Errors found are corrected in the Excel database file and otolith notebook.

References:

Durif, C., Guibert, A., Elie, P. 2009. Morphological discrimination of the silvering stages of the European eel. American Fisheries Society Symposium 58, 103-111.

Appendix 1

Electrofishing protocol for eel surveys in rivers.

Upes nosaukums		**Datums**	
Vietas apraksts	Piem., Venta pie Kuldīgas vecā tilta		
Projekts/Mērķis			
Koordinātes	**x:**	**y:**	

Zvejas laiks	**sākums**	**beigas**	**Zvejas atkārtojumi**	**Zvejas dalībnieki:** (Uzvārdi) **Aizpildītja:**			
Zvejas iekārta	**KC Denmark**	**SE 300**	**SE 500**	**KC Denmark mugursoma**	**E-fish mugursoma**	**EFBP400 mugursoma**	**Hans Grassl**

Parauglaukuma apraksts	**Plat**	**Gar**	**Vid dziļums**	**Max dziļums**	**Parauglaukuma veids**	**Straumes ātrums m/s**	**Aizēnojums**
Paraugs:					*visā upes platumā*	vid:	*nav*
					daļēji		*dažviet*
Upes platums:					*gar krastu*	max:	*pārsvarā*
					no laivas (krasts)		*pilnīgs*

Biotops %	krāce	straujtece	lēntece
Krastu erozija	nav	mērena	spēcīga

Aizauguma intensitāte	nav	maz	vidēja	daudz	nosegta virsma	
	0%	<30%	30-60%	>60%	100%	
Ūdensaugi	Nimfeīdi	Elodeīdi	Helofīti	Lemnīdi	Aļģes	Sūnas

Apkārtējās zemes izmantošana (%)	mežs	pļavas	tīrumi	parks	krūmājs	apdzīvota vieta	rūpniecība

Piesārņojums *(apraksīt)*	nav pazīmju	iespējami piesārņojuma avoti	acīmredzami piesārņojuma avoti

Substrāta neorganiskie komponenti		**Substrāta organiskie komponenti**			**Antropogēni pārveidojumi (ir/nav)**	
Substrāta tips	**%**	**Substrāta tips**	**Raksturojums**	**%**	Sen rakts	
Industriāli materiāli		Detrīts	*Atsevišķi koki, to atliekas*		Nesen rakts	
Pamatiezis					Veikta grunts uzirdināšana	
Laukakmeņi (>256mm)			*Zagari, lapas, lakstaugu atliekas*		Veikta substrāta skalošana	
Oļi (64-256mm)		Dūņas	*Melnas, smalkas*		Bērti oļi/laukakmeņi	
		Merģelis	*Pelēkas, gliemežu čaulu fragmenti*		Izzāģēti kritušie koki upē	
Grants (2-64mm)					Izzāģēti koki krastā	
Smilts (0.06-2mm)		**Koku sanesumi** (skaits un novietojums)		**Bebru dambji** (skaits un novietojums)	Izpļauti ūdensaugi	
Nogulumi (0.004-0.06mm)					Izveidots dambis augšpus/lejpus	
Māls (<0.004)						

	T °C	**O₂ mg/l**	**pH**	**EC µS/cm**	**Duļķainība**	**Ūdens krāsa**
Ūdens kvalitāte					*dzidrs*	
					nedaudz duļķains	
					duļķains	
					necaurredzams	

Piezīmes:	
Foto Nr.	**Nimfeīdi** - lapas un ziedi uz ūdens virsmas (ūdensrozes, lēpes, bultenes, ežgalvītes, glīvenes); **Elodeīdi** – pilnībā zem ūdens, izņemot ziedus (elodejas, daudzlapes, glīvenes) **Helofīti** – virsūdens un krastmalu augi (niedres, vilkvāles, ežgalvītes); **Lemnīdi** – peldošie, nesakņojas (ūdensziedi, mazlēpes) Piezīme: ūdensauga kategorija atkarīga no tā lapu novietojuma ūdenī, dažām sugām tā var mainīties.

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☐ **Nomērīts viss!**

☐ **Paņemts paraugs analīzei laboratorijā**

Appendix 2

Electrofishing protocol for eel surveys in lakes

Elektrozvejas protokols zušu uzskaitēm ezeros

Nr.	Dat.	Mēn.	Gad.	Parauglaukums-transektes Nr.	Noķerto zušu skaits	x sākums	y sākums	x beigas	y beigas	Sākuma laiks	Beigu laiks	Zvejas ilgums (min)	Parauglaukuma garums (m)	EC	O2	pH	℃	Vizuāli piefiksēti zuši - skaits
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Appendix 3

Distribution of sampling sites for yellow eel surveys in rivers.

River	UBA	WGS_84 x	WGS_84 y	Upe	UBA	WGS_84 x	WGS_84 y
DAUGAVA	Daugava	56.871316	24.228634	MĒMELE	Lielupe	56.3889	24.70403
DAUGAVA	Daugava	56.852971	24.219689	MĒMELE	Lielupe	56.32367	24.56696
DAUGAVA	Daugava	57.06273	24.10363	MĒMELE	Lielupe	56.34266	24.43951
DAUGAVA	Daugava	57.06641	24.09812	MĒMELE	Lielupe	56.40588	24.1775
DAUGAVA	Daugava	57.0645	24.1005	MŪSA	Lielupe	56.30031	24.32362
LIELĀ JUGLA	Daugava	56.977526	24.619886	MŪSA	Lielupe	56.32642	24.26695
LIELĀ JUGLA	Daugava	56.965531	24.530842	MŪSA	Lielupe	56.39979	24.19258
LIELĀ JUGLA	Daugava	56.974098	24.689255	ABAVA	Venta	57.02051	22.686301
MAZĀ JUGLA	Daugava	56.896661	24.510194	ABAVA	Venta	57.085899	22.506373
MAZĀ JUGLA	Daugava	56.891781	24.527243	BĀRTA	Venta	56.31005	21.4485
GAUJA	Gauja	57.27208	25.10579	BĀRTA	Venta	56.33221	21.30937
GAUJA	Gauja	57.26686	25.09618	CIECERE	Venta	56.680178	22.045017
GAUJA	Gauja	57.258	25.07848	DURBE	Venta	56.757918	21.298537
GAUJA	Gauja	57.25259	25.05633	DURBE	Venta	56.753548	21.309759
GAUJA	Gauja	57.44958	26.34572	IRBE	Venta	57.578379	21.978155
PĒTERUPE	Gauja	57.241703	24.442218	IRBE	Venta	57.572114	21.94438
PĒTERUPE	Gauja	57.257281	24.420617	IRBE	Venta	57.551932	21.868141
SALACA	Gauja	57.84311	24.484433	RINDA	Venta	57.534276	21.914238
SALACA	Gauja	57.838121	24.484985	RĪVA	Venta	56.846377	21.75764
SALACA	Gauja	57.809033	24.464584	RĪVA	Venta	56.94025	21.36698
SALACA	Gauja	57.809033	24.464584	RĪVA	Venta	56.95219	21.35319
SALACA	Gauja	57.766456	24.460624	RĪVA	Venta	56.973666	21.348514
SALACA	Gauja	57.754899	24.14249	ROJA	Venta	57.444722	22.732899
SVĒTUPE	Gauja	57.715705	24.434926	TEBRA	Venta	56.83189	21.406809
SVĒTUPE	Gauja	57.718561	24.48867	TEBRA	Venta	56.83312	21.397167
VITRUPE	Gauja	57.65066	24.46557	UŽAVA	Venta	57.104812	21.561024
VITRUPE	Gauja	57.64881	24.42925	UŽAVA	Venta	57.124835	21.549608
IECAVA	Lielupe	56.62341	24.18291	VENTA	Venta	56.411968	22.216871
IECAVA	Lielupe	56.62241	24.1085	VENTA	Venta	56.970037	21.978284
LIELUPE	Lielupe	56.44423	24.04761	VENTA	Venta	56.973106	21.972175
LIELUPE	Lielupe	56.40581	24.11966	VENTA	Venta	56.980667	21.970336
MĒMELE	Lielupe	57.26091	25.13981	VENTA	Venta	57.017681	21.961389
MĒMELE	Lielupe	56.44086	24.86374	VENTA	Venta	57.10084	21.798602
MĒMELE	Lielupe	56.38885	24.70403				

Appendix 4

Protocol for biological measurements and marking of silver eels.

Nr.	D	M	G	Vieta	Zīmītes Nr.	Garums (cm)	Svars (g)	Av	Ah	Sp	Krāsa
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