Guidelines for collecting biological data for assessing Atlantic salmon (*Salmo salar*) and brown trout (*Salmo trutta*) populations.

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1. Introduction

The Internal Waters and Fish Resources Research Department of the Food Safety, Animal Health, and Environment Institute BIOR conducts research on salmonid fish resources in Latvian rivers. This includes organizing research surveys and collecting samples from commercial fishing catches along the coast and in the open sea. This document describes the methods and biological information collected.

2. Assessment of salmon stocks

The assessment of salmon and trout stocks in the Baltic Sea is coordinated by the International Council for the Exploration of the Sea (ICES). The assessment of salmon and trout stocks is carried out by the ICES Working Group on Baltic Salmon and Trout Assessment (WGBAST), which involves specialists from all Baltic Sea countries and utilizes data on salmon and trout catches and research surveys provided by these countries.

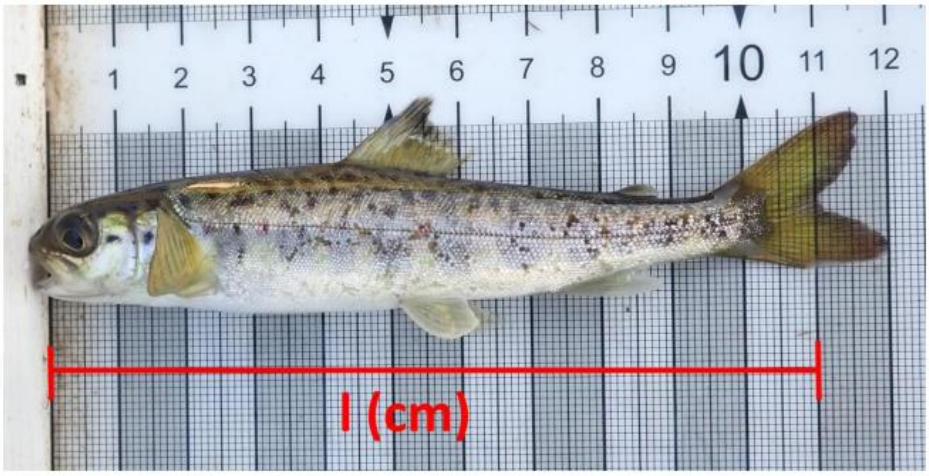
3. Data collection

3.1. Evaluation of juvenile salmon and trout production

The counting of juvenile salmon and trout is conducted annually using stationary (SE 300; KC Denmark) or backpack-type (EFBP400, KC Denmark) electrofishing equipment, covering an area of 250-350 m2. The surveys are conducted in rapid-flowing habitats (Appendix 1, 2) 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." In the Salaca River Basin, the surveys are repeated three times, while in other salmon rivers, the surveys are conducted once.

3.1.1. Biological measurements

Measurements of the length of juvenile salmon and trout are taken up to the nearest millimetre, including the caudal fork length (l) (Appendix 3).



The juveniles are grouped into 0+ and >0+ age groups based on their length. To validate the age grouping, scale samples are collected from five fish within each length group to determine their age.

3.1.2. Quality of Biological Data

The biological data is entered and summarized in Excel database format. The biological parameters have defined limits (minimum and maximum acceptable values). Once the data on salmon and trout fry enumeration is entered, an analysis of fish length data is performed (independently reviewed by two researchers). If necessary, erroneous entries are corrected in the Excel database file and electrofishing protocol.

3.1.3. Calculation of Juvenile Salmon and Trout Production

The calculation of salmon and trout fry production is done using the Seber method in sampling areas where electrofishing is conducted two or three times in a row.

$$N = \frac{6A^2 - 3AT - T^2 + T\sqrt{T^2 + 6AT - 3A^2}}{18\,(A - T)},$$

Where N represents the theoretical density of individuals within the population;

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

where c1 represents the number of individuals captured in the first survey, c2 represents the number of individuals captured in the second survey, and c3 represents the number of individuals captured in the third survey.

$$A = 2c_1 + c_2$$

In sample areas where fish are captured only once, the number of salmon and trout fry is calculated using a coefficient p, which represents the probability of capturing a portion of fish in the first fishing survey.

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

The values of p are calculated from a combined sample that includes the summation of all the counts of salmon and trout fry from the sample areas where fish are captured three times. For the 0+ age group, the recalculated coefficient p is 0.6, while for older fry (>0+), it is 0.8.

The density of salmon and trout fry is recalculated per 100 m2.

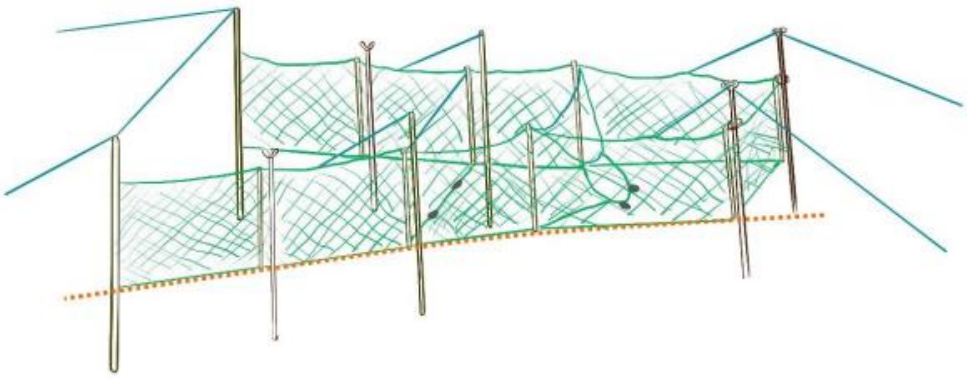
3.2. Smolt Production Assessment

3.2.1. Methodology for Smolt Enumeration

Enumeration of salmon and trout smolts is conducted using a specialized smolt trap. The trap has a wing length of 20 meters and an opening for the fish to enter. The eye size of the fish is between 10-24mm.

Every year, the smolt trap is installed in the Salaca River in early April when the water temperature reaches 6-8°C. The trap is positioned with the opening facing the current as close as possible to the main stream.

Pot scheme



Considering that the smolt pot covers only a portion of the river, the effectiveness (capture rate) of the pot during the counting period is assessed by marking captured salmon and trout smolts with polyethylene streamer-type tags with unique numbering. The marked fish are released 3 km upstream of the pot. Recoveries of marked fish allow for the calculation of the total number of migrating smolts. The formula for calculating pot efficiency is as follows:

$$U = \frac{R}{M}$$

where U is the pot efficiency, R is the number of marked smolts recovered from the pot, and M is the total number of marked smolts.

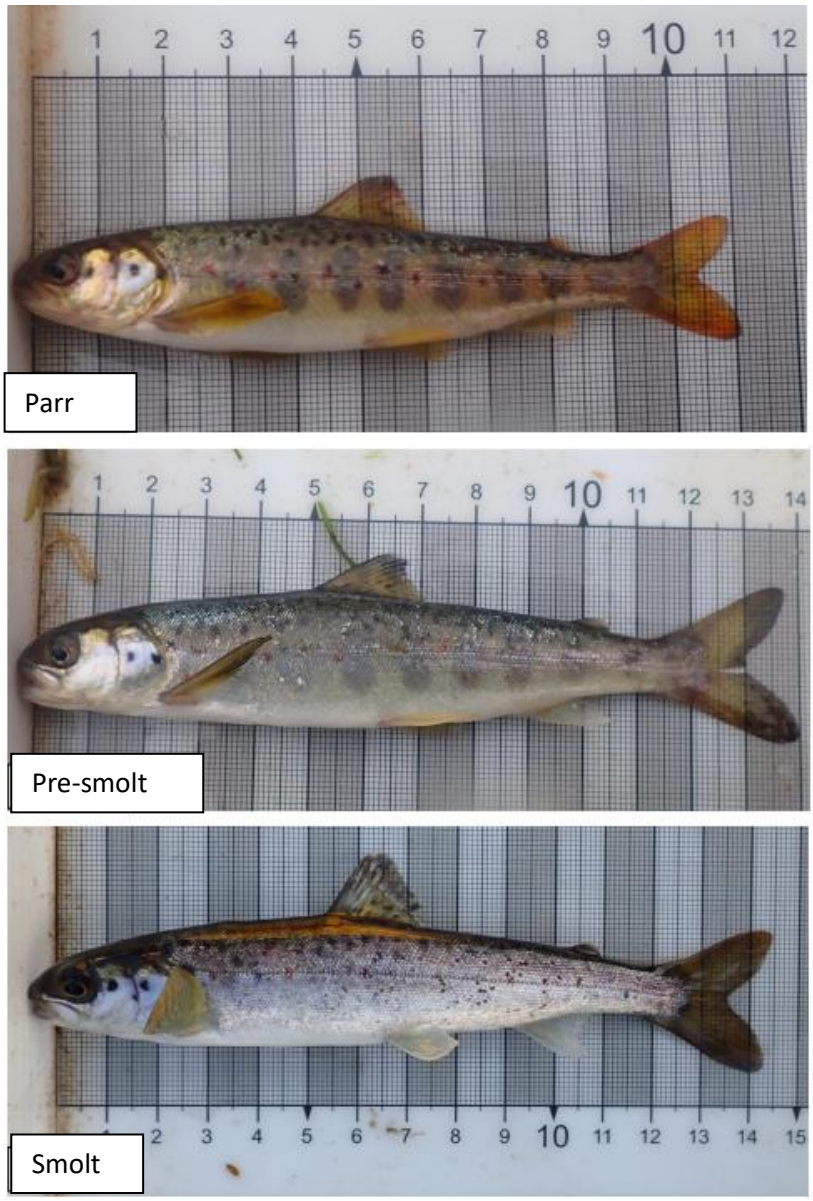
3.2.3. Biological measurements

The stage of smoltification is assessed. In smolt production calculations, only pre-smolts and smolts are taken into account. Length measurements are taken for all captured salmon up to the caudal fin (see 3.1.1.). A scale sample for age determination is collected from every fifth salmon, indicating the sample number, species, length, stage, and capture date in the scale book. Photographic documentation is conducted for every tenth salmon (see Appendix 4). Scale samples are collected from at least 100 smolts.

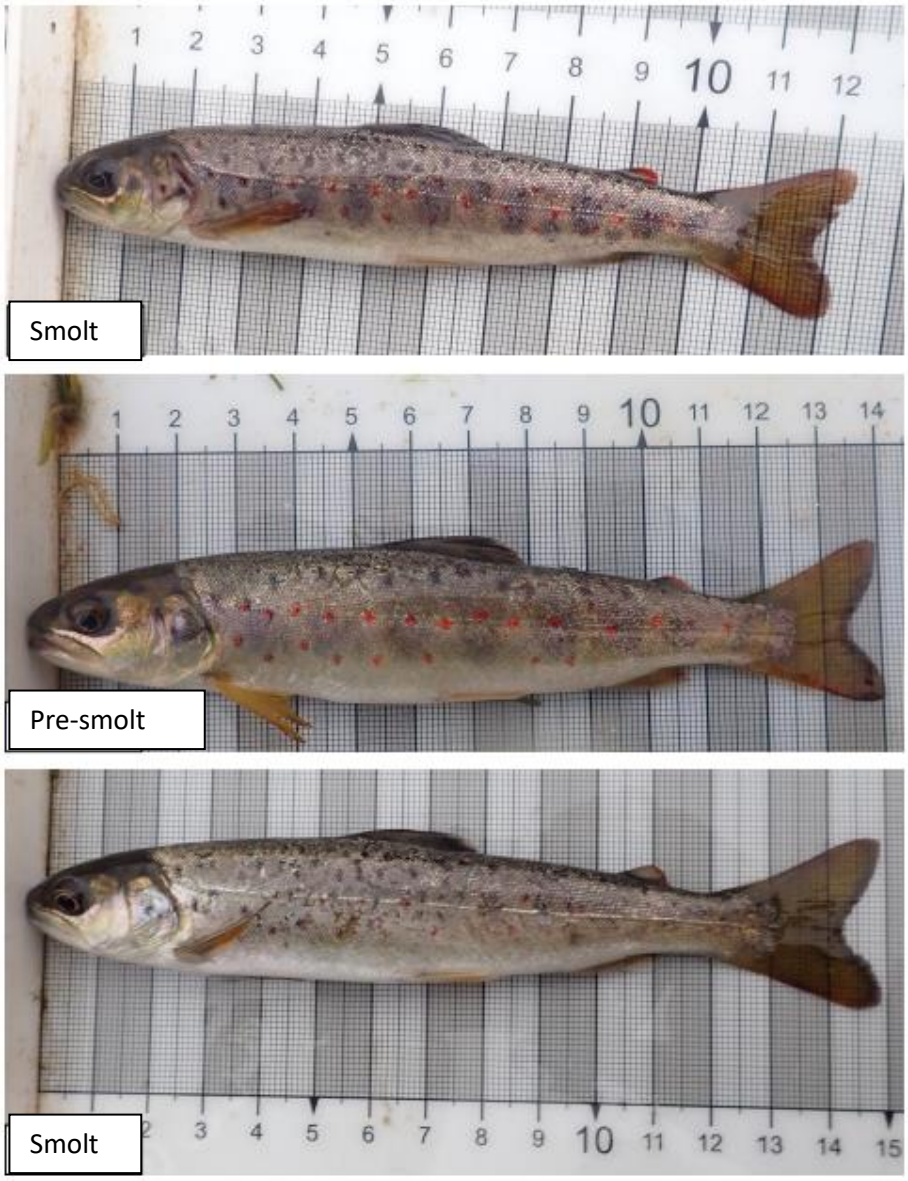
3.2.4. Quality of biological data

Biological data is input and compiled in Excel database format. Biological parameters have defined limits (minimum and maximum allowable values). After entering the data for smolt counting, an analysis of fish length data is performed, and erroneous entries are corrected if necessary. Biological data validation is also conducted during age determination. The age determiner compares the records for each specific fish with the information in the scale book and the entries in the smolt counting protocol. Any errors found are corrected in the Excel database file and the smolt counting protocol.

Stages of salmon smoltification



Stages of trout smoltification



3.2.5. Calculation of Smolt Production

The smolt production is assessed using the Petersen population estimation formula.

$$U_i = \frac{u_i\,(M_i + 1)}{m_i + 1},$$

Where Ui is the total smolt production during the survey period, u_i is the number of unmarked smolts caught during the survey period, M is the number of marked smolts released during the survey period, and mi is the number of marked smolts recaptured during the survey period. The following formula is used for variance calculation (Carlson et al., 1998):

the confidence interval:

$$U_i \pm 1{,}96\sqrt{(V\ (U_i))}.$$

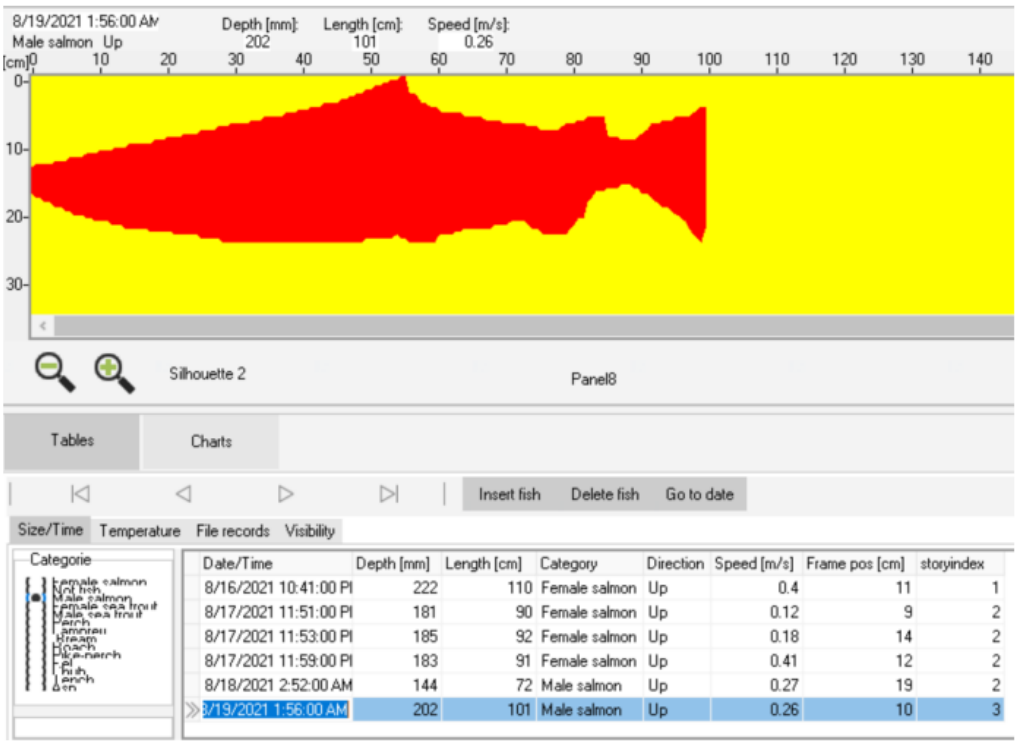
3.3. Automated Counting of Upstream Migrating Salmon and Parr

For the automated counting of upstream migrating salmon and parr, a VAKI Riverwatcher automatic fish counter is installed in early July in the Salaca River at Vecsalaca. The automated fish counter is integrated with a selective barrier structure to facilitate the counting process. The installed automatic fish counter with the selective barrier structure in Salaca allows for efficient and accurate monitoring of the upstream migration of salmon and parr.

The automatic fish counter with a demarcation fence structure is installed in Salaca River.

All cases of upstream migration of salmon and parr through the scanner and photo tunnel are automatically recorded, providing information about species, gender, size, and total count. Continuous monitoring of migrating salmon and parr is conducted until the end of November, with the exact end date depending on hydrological conditions. At least once a week, the recorded data is downloaded and backed up on data carriers. Each entry is reviewed and verified by an employee of the Institute.

The silhouette of a male salmon from the VAKI Riverwatcher automatic fish counter installed in Salaca.

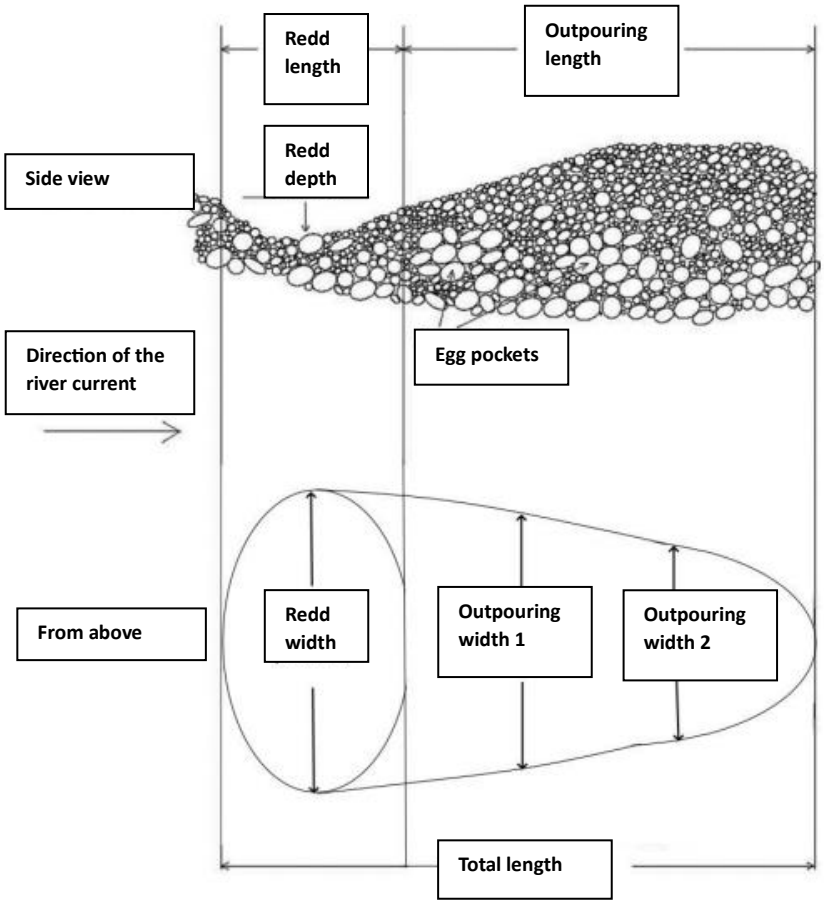


Screenshot of a female salmon captured by the VAKI Riverwatcher automatic fish counter in Salaca.

3.4. Counting of salmon and trout spawning redds

In late October and early November, in Salaca and, if possible, in other rivers suitable for salmon and trout, the counting of spawning redds and nests is conducted in rapid sections with suitable gravel and pebble substrates. The counting is done from a boat or while wading. The counting of spawning redds provides additional information about the volume of spawning fish in the river and the utilization of suitable areas for spawning. This information is valuable in relation to the results of fry surveys. Spawning redds and nests are visually identified. Measurements of counted redds and individual nests are also taken.

The parameters of spawning redds



3.5. Collection of fishing data

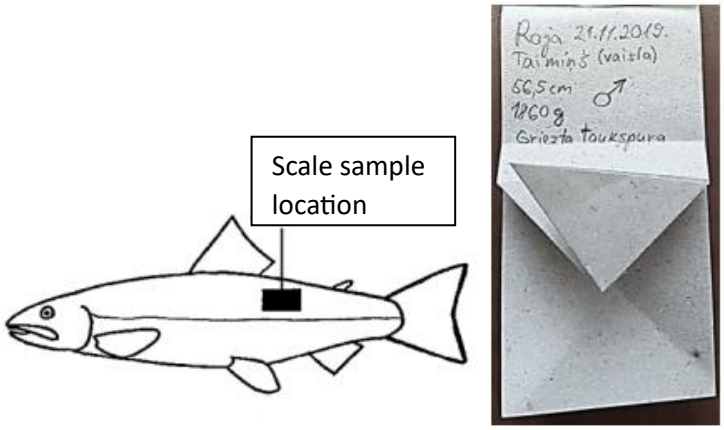
Institute annually enters into agreements with collaborative fishermen for the collection of fishing data. These fishermen use nets to fish along the coast, aiming to cover the entire coastline, with a focus on coastal areas related to salmon and rivers where salmon fry naturally occur. Additionally, each year an agreement is made with a collaborative fisherman who collects at least 200 biological samples of salmon and trout through hook and line fishing in the open sea within ICES Subarea 26 and 28.

3.5.1. Biological Analysis

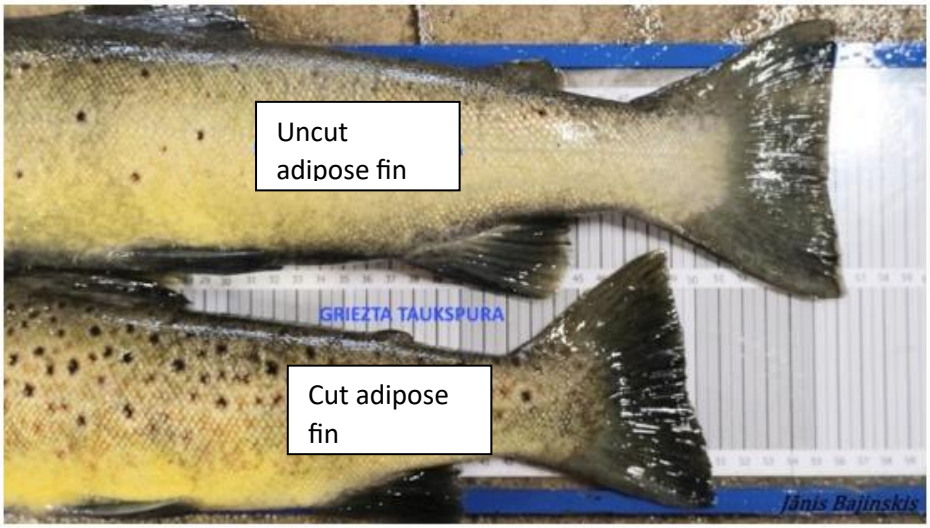
Information about the capture location, date, species, length, weight, gender, and condition of adipose fin is collected from captured salmon and trout in coastal and open sea fishing. For the analysed salmon and trout caught in the open sea through hook and line fishing, the weight of the fish on the hook is indicated. Therefore, a conversion coefficient of 1.1 is applied for the calculation of the fish's full weight.

Considering that the number of salmon and trout caught in Latvian coastal and open sea fishing is relatively small, biological information is collected from all captured salmon and trout. A scale sample is taken from each salmon or trout for age determination.

Sampling location and example of a completed sampling logbook



Evaluation of adipose fin condition



In open-sea hook-and-line fishing, tissue samples (a small piece of caudal fin) are collected from all analysed salmon for genetic analysis. These tissue samples are stored in Eppendorf tubes filled with 96% ethanol.

3.5.2 Biological data quality

Biological data is entered and compiled in Excel database format. Biological parameters have defined limits, including minimum and maximum allowable values. Once the data on salmon and trout are entered, an analysis of fish length and weight data is performed. A linear regression model is created to determine the trend line and forecast confidence intervals. Entries that fall outside the confidence intervals are flagged as erroneous and are rechecked and corrected if necessary. Another round of data validation takes place when age determination is conducted. The age determiner compares the records for each specific fish with the information in the logbook and the database entries. Any identified errors are corrected in the Excel database file and the logbook.

Appendix 1

The placement of long-term sampling sites for the monitoring of juvenile salmon.

River	Type	Sampling site	WGS84 x	WGS84 y
Salaca	W	Sarkanās klintis	57.84311	24.48443
		Munas lielā straume	57.80903	24.46458
		Munas mazā straume	57.80903	24.46458
		Brūveļi	57.76646	24.46062
		Inspekcija	57.75490	24.14249
Jaunupe	W	Leja	57.74831	24.40146
		Vidus	57.73191	24.41548
		Augša	57.71691	24.43704
Svētupe	W	Kuiķule	57.71571	24.43493
		Avotkalni	57.71856	24.48867
Korģe	W	Leja	57.75902	24.45775
Vitrupe	W	Brīdaga	57.65067	24.46529
		Pagastu robeža	57.64881	24.42925
Pēterupe	W	Rozes	57.24170	24.44222
		Pie dzelzceļa	57.25728	24.42062
Irbe	W	Tilta vieta Irbenē	57.55210	21.86795
		Pret Menstiem	57.57211	21.94438
		Pret Beržezeru	57.57838	21.97817
Užava	W	Pie Jaunbriežiem	57.10481	21.56102
		Pie Brenčiem	57.12484	21.54961
Tebra	W	Virs Plieņiem	56.83189	21.40681
		Pie Akmeņkalniem	56.83312	21.39717
Durbe	W	261/00 meliorācijas pikets	56.75792	21.29854
		272/00 meliorācijas pikets	56.75355	21.30976
Bārta	W	Lejpus Baltkrūmiem	56.31005	21.4485
Gauja	M	Ķūķu klintis	57.27208	25.10579
		1 km lejpus Ķūķu klintīm	57.26686	25.09618
		Skaļupes ieteka	57.25800	25.07848
		Pirms pārceltuves	57.25259	25.05633
		Lejpus Randatu klintīm	57.44958	26.34572
Amata	M	Leja	57.26094	25.13989
		Pie Zvārtas ieža	57.24706	25.14324
		Pie audzētavas	57.23707	25.19746
Venta	M	Kuldīgas vecais tilts	56.97004	21.97828
		Pirts	56.97311	21.97218
		Pārceltuve	56.98067	21.97034
		Padure	57.01768	21.96139
		Zlēkas	57.10217	21.79554
Mazā Jugla	M	Virs Elmāriem	56.90418	24.45798
		Pie Saleniekiem 57	56.89459	24.47613
Lielā Jugla	M	Virs Upeņēm	56.96547	24.53026
		Pie Krupīšiem	56.95779	24.55127
		Pie Sauleskalna	56.96759	24.51691
Aģe	W	Zvejniekciems	57.31797	24.42006
		Pie bērnudārza laipas	57.32600	24.49124

W - natural population

M - mixed population

Appendix 2

Placement of long-term sampling sites for counting fry of salmonids.

River	Sampling site	WGS84 x	WGS84 y
Rinda	Pirms ietekas Irbē	57.534276	21.914238
Zaķupe	Tūjā	57.490552	24.400560
Vitrupe	Tilts pie Brīdagas	57.650660	24.465570
Vitrupe	Virs pagastu robežas	57.648810	24.429250
Svētupe	Pie Avotkalniem	57.715705	24.434926
Svētupe	Ķuiķule	57.718561	24.488670
Jaunupe	Leja	57.748314	24.401456
Jaunupe	Vidus	57.731907	24.415482
Jaunupe	Augša	57.716908	24.437042
Korģe	Leja	57.759019	24.457752
Korģe	Pret Jaunoļķiem	57.762523	24.467910
Noriņa	Lejpus pirmā tilta	57.830515	24.490076
Pēterupe	Rozēs	57.241703	24.442218
Pēterupe	Pie dzelzceļa	57.257281	24.420617
Ķīšupe	Lejpus dzelzceļa	57.273676	24.427645
Mazupīte	Augšpus V128 tilta	57.329400	24.448300
Šķērvelis	Pirms ietekas Ventā	56.573535	21.981366
Zaņa	Pirms grīvas	56.475347	22.113467
Losis	Pret Loša atsegumu	56.468239	22.112630
Vadakste	Pirms grīvas	56.411944	22.218867
Lētīža	Meldzeres kapi	56.488035	21.945684
Apše	Pie Svipstu kapiem	56.290259	21.491607
Rīva	Valātos	56.846377	21.757640
Rīva	Virs 2. tilta	56.940250	21.366980
Rīva	Pie mednieku namiņa	56.952190	21.353190
Rīva	Pie Rīvas kroga	56.973666	21.348514
Vanka	Pie Ošiem	57.035238	21.644500
Pitragupe	Abpus P124	57.688671	22.377359
Pilsupe	Pie Puiškalna	57.541750	22.508422
Roja	Mārkciemā	57.444722	22.732899
Lāčupīte	Tilts augšpus Siliem	57.051883	23.287947
Loja	Loja_Viršu_iela	57.132146	24.666871
Vaive	Vaive_dzirnavas	57.331210	25.391800
Amata	Amata_leja	57.260740	25.140007
Amata	Amata_Zvārta	57.247097	25.143105
Amata	Amata_audzētava	57.237444	25.197412
Vecpalsa	Vecpalsa_V368	57.461450	26.348430
Strīķupe	Strīķupe_lejpus_Stūrīšiem	57.394500	25.273480
Strīķupe	Strīķupe_Kalējala	57.379540	25.263150
Rauna	Rauna_Raunas	57.335820	25.413800
Raunis	Raunis_P28	57.328730	25.405960
Raunis	Raunis_estrāde	57.286159	25.465326
Nurmižupīte	Nurmižupīte_Vecdzintari_caurteka	57.198500	24.917220
Vējupīte	Vējupīte_lejpus_V83	57.160110	24.885200
Egļupe	Egļupe_lejpus_A2	57.134380	24.723300
Lenčupe	Lenčupe_Sila_dzirnavas	57.349820	25.194950
Skaļupe	Skaļupe_V283	57.254670	25.078730
Vildoga	Vildoga_V328	57.223500	24.976010
Kumada	Kumada_Kraujas	57.215320	25.161710
Karogupīte	Pirms ietekas Salacā	57.834370	24.787110

Appendix 3

Electrofishing protocol

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) **Aizpildīja:**			
Zvejas iekārta	**KC Denmark**	**SE 300**	**SE 500**	**KC Denmark mugursoma**	**E-fish mugursoma**	**EFBP400 mugursoma**	**Hans Grassl**

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

Biotops %	krāce	straujtece	lēntece
Krastu erozija	nav	mērena	spēcīga

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

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

Piesārņojums *(apraksti)*	nav pazīmju	iespējami piesārņojuma avoti	ačīmredzami 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)			*Žagari, lapas, lakstaugu atliekas*		Veikta substrāta skalošana	
Oļi (64-256mm)		Dūņas	*Melnas, smalkas*		Bērti oļi/laukakmeņi	
		Merģelis	*Pelēkas, gliemežu čaulu fragmenti*		Izzāģēti krītušie 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	**O_2 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, vilkvālles, ežgalvītes); **Lemnīdi** – peldošie, nesakņojas (ūdenszieds, 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 4

Smolt counting protocol.

murda ielikšanas dat.		ielikts (laiks)	:	vēja stiprums	
murda pārbaudes dat.		pārbaude (laiks)	:	vēja virziens	

skaidrs		mākoņains		apmācies		līst	

ūdens temperatūra	

ūdens līmenis	

Lasis (cm)	Zīm. nr.	Taimiņš (cm)	Zīm. nr.	Lasis (cm)	Zīm. nr.	Taimiņš (cm)	Zīm. nr.
1 F		1 F		36		36	
2		2		37		37	
3		3		38		38	
4		4		39		39	
5 Z		5 Z		40 ZF		40 ZF	
6		6		41		41	
7		7		42		42	
8		8		43		43	
9		9		44		44	
10 ZF		10 ZF		45 Z		45 Z	
11		11		46		46	
12		12		47		47	
13		13		48		48	
14		14		49		49	
15 Z		15 Z		50 ZF		50 ZF	
16		16		51		51	
17		17		52		52	
18		18		53		53	
19		19		54		54	
20 ZF		20 ZF		55 Z		55 Z	
21		21		56		56	
22		22		57		57	
23		23		58		58	
24		24		59		59	
25 Z		25 Z		60 ZF		60 ZF	
26		26		61		61	
27		27		62		62	
28		28		63		63	
29		29		64		64	
30 ZF		30 ZF		65 Z		65 Z	
31		31		66		66	
32		32		67		67	
33		33		68		68	
34		34		69		69	
35 Z		35 Z		70 ZF		70 ZF	

CITAS SUGAS

suga	daudzums						

SMOLTU ATGUVUMI

Zīm. nr.							

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