fishes

Supplementary materials

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Thiamine Deficiency M74 Developed in Salmon (*Salmo salar*) Stocks in Two Baltic Sea Areas after the Hatching of Large Year-Classes of Two Clupeid Species—Detected by Fatty Acid Signature Analysis.

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Table S1. Mean (± SE) proportions of fatty acids (FAs) and sums of FA structural classes, and body parameters (body mass, length, and condition factor, CF), lipid content in muscle and eggs, and the concentrations of free thiamine (THIAM) in muscle and in unfertilized eggs of River Simojoki salmon female spawners of the M74 year 2016 from the Baltic Proper and Gulf of Bothnia feeding areas. A significant difference (*p* value) in one-way ANOVA between the salmon groups is indicated by the larger mean being in bold face.

Variable	**Muscle**									**Eggs**								
	Baltic Proper				**Gulf of Bothnia**				*p*	**Baltic Proper**				**Gulf of Bothnia**				*p*
14:0, %	1.34	±	0.09	22	1.38	±	0.03	8	0.789	**1.22**	**±**	**0.03**	22	1.04	±	0.02	8	0.001
16:0, %	12.56	±	0.25	22	12.22	±	0.22	8	0.446	**12.10**	**±**	**0.07**	22	11.75	±	0.19	8	0.044
17:0, %	**0.25**	**±**	**0.01**	22	0.22	±	0.01	8	0.003	**0.25**	**±**	**0.00**	22	0.21	±	0.01	8	<0.0001
18:0, %	**3.75**	**±**	**0.05**	22	3.39	±	0.07	8	0.001	4.59	±	0.05	22	4.51	±	0.08	8	0.444
16:1*n*–7, %	2.64	±	0.07	22	**4.42**	**±**	**0.12**	8	<0.0001	4.10	±	0.07	22	**5.83**	**±**	**0.21**	8	<0.0001
17:1*n*–8, %	**0.70**	**±**	**0.02**	22	0.49	±	0.01	8	<0.0001	**0.82**	**±**	**0.01**	22	0.59	±	0.01	8	<0.0001
18:1*n*–7, %	3.11	±	0.06	22	**4.23**	**±**	**0.06**	8	<0.0001	3.58	±	0.06	22	**4.76**	**±**	**0.10**	8	<0.0001
18:1*n*–9, %	**21.27**	**±**	**0.32**	22	19.28	±	0.24	8	0.001	**24.20**	**±**	**0.22**	22	20.73	±	0.32	8	<0.0001
20:1*n*–9, %	1.47	±	0.04	22	**1.83**	**±**	**0.09**	8	0.0002	0.32	±	0.01	22	0.30	±	0.01	8	0.131
18:2*n*–6, %	2.80	±	0.06	22	**4.57**	**±**	**0.14**	8	<0.0001	2.79	±	0.04	22	**4.48**	**±**	**0.15**	8	<0.0001
20:2*n*–6, %	0.62	±	0.01	22	**1.47**	**±**	**0.09**	8	<0.0001	0.28	±	0.01	22	**0.51**	**±**	**0.03**	8	<0.0001
18:3*n*–3, %	1.71	±	0.03	22	**2.02**	**±**	**0.08**	8	<0.0001	2.12	±	0.03	22	**2.62**	**±**	**0.06**	8	<0.0001
20:4*n*–6, %	0.64	±	0.01	22	**0.78**	**±**	**0.03**	8	<0.0001	1.05	±	0.02	22	**1.14**	**±**	**0.02**	8	0.004
20:5*n*–3, %	6.06	±	0.13	22	6.27	±	0.16	8	0.367	8.76	±	0.14	22	8.46	±	0.18	8	0.271

Variable	Muscle									Eggs								
	Baltic Proper				Gulf of Bothnia				*p*	Baltic Proper				Gulf of Bothnia				*p*
22:5*n–3*, %	4.78	±	0.25	22	**5.80**	**±**	**0.11**	8	0.023	5.69	±	0.10	22	5.95	±	0.09	8	0.149
22:6*n–3*, %	**26.13**	**±**	**0.56**	22	19.63	±	0.49	8	<0.0001	**19.94**	**±**	**0.22**	22	17.75	±	0.47	8	<0.0001
SFA, %	19.10	±	0.36	22	18.11	±	0.31	8	0.131	**19.13**	**±**	**0.12**	22	18.28	±	0.25	8	0.002
MUFA, %	31.67	±	0.41	22	32.66	±	0.45	8	0.190	34.00	±	0.27	22	33.16	±	0.55	8	0.140
PUFA, %	46.33	±	0.63	22	47.02	±	0.37	8	0.523	43.67	±	0.32	22	**45.64**	**±**	**0.45**	8	0.003
n–3 PUFA, %	**39.55**	**±**	**0.65**	22	34.99	±	0.64	8	0.0004	33.54	±	0.29	22	32.93	±	0.51	8	0.290
n–6 PUFA, %	4.31	±	0.07	22	**7.21**	**±**	**0.21**	8	<0.0001	4.24	±	0.04	22	**6.30**	**±**	**0.16**	8	<0.0001
Mass, kg	**6.48**	**±**	**0.25**	21	5.05	±	0.22	8	0.002									
Length, cm	**87.6**	**±**	**1.0**	21	82.1	±	0.8	8	0.003									
CF	0.96	±	0.01	21	0.91	±	0.02	8	0.068									
Lipid, %	5.75	±	0.47	22	5.49	±	0.36	8	0.749	8.37	±	0.23	22	8.24	±	0.48	8	0.792
THIAM, nmol g^{-1}										**1.95**	**±**	**0.36**	22	0.29	±	0.08	8	0.011

Table S2. Mean (± SE) body mass, total length, and condition factor (CF) of salmon female spawners from the Baltic Rivers Simojoki, Dal, and Neris in 2014–2017 classified as Baltic Proper and the Gulf of Bothnia feeding areas, and those of the River Tenojoki from the Arctic Ocean in 1997, with the number of samples. The concentrations of thiamine components (TPP = thiamine pyrophosphate, TMP = thiamine monophosphate, and THIAM = free thiamine) and total thiamine (TotTh) and lipid content and the proportions of fatty acids and their structural classes in unfertilized eggs are also given. A different superscript letter indicates a significant ($p < 0.05$, *post hoc* Student-Newman-Kuels test) difference between the groups.

	River Simojoki 2014 Baltic Proper				**River Simojoki 2016 Baltic Proper**				**River Simojoki 2016 Gulf of Bothnia**				**River Tenojoki 1997 Arctic Ocean**			
Mass, kg	7.00	±	0.54^{ab}	13	6.48	±	0.24^{a}	21	5.05	±	0.22^{a}	8	9.13	±	1.07^{b}	8
Length, cm	91.1	±	1.9^{bc}	13	87.6	±	1.0^{ab}	21	82.1	±	0.8^{a}	8	97.9	±	3.8^{c}	8
CF	0.91	±	0.02^{a}	13	0.96	±	0.01^{ab}	21	0.91	±	0.02^{a}	8	0.93	±	0.03^{ab}	8
TPP, nmol g^{-1}	0.43	±	0.02^{bc}	14	0.45	±	0.02^{bc}	22	0.37	±	0.03^{ab}	8	0.59	±	0.08^{d}	5
TMP, nmol g^{-1}	0.40	±	0.02^{e}	14	0.21	±	0.01^{bcd}	22	0.14	±	0.01^{ab}	8	0.18	±	0.01^{abcd}	5
THIAM, nmol g^{-1}	5.91	±	0.72^{b}	14	1.95	±	0.36^{a}	22	0.29	±	0.08^{a}	8	6.81	±	0.37^{b}	5
TotTH, nmol g^{-1}	6.74	±	0.73^{b}	14	2.62	±	0.38^{a}	22	0.80	±	0.18^{a}	8	7.59	±	0.44^{b}	5
Egg lipid, %	9.50	±	0.35^{ab}	14	8.37	±	0.23^{a}	22	8.24	±	0.48^{a}	8	11.11	±	0.36^{c}	8
14:0, %	1.18	±	0.03^{ab}	14	1.22	±	0.03^{ab}	22	1.04	±	0.02^{a}	8	2.39	±	0.14^{c}	8
16:0, %	12.19	±	0.12^{bc}	14	12.10	±	0.07^{bc}	22	11.75	±	0.19^{b}	8	13.22	±	0.11^{d}	8
17:0, %	0.23	±	0.00^{bc}	14	0.25	±	0.00^{cde}	22	0.21	±	0.01^{b}	8	0.15	±	0.01^{a}	8
18:0, %	4.73	±	0.07^{bc}	14	4.59	±	0.05^{bc}	22	4.51	±	0.08^{bc}	8	4.31	±	0.10^{b}	8
16:1*n*–7, %	3.83	±	0.09^{a}	14	4.10	±	0.07^{ab}	22	5.83	±	0.21^{e}	8	4.97	±	0.16^{cd}	8
17:1*n*–8, %	0.66	±	0.01^{d}	14	0.82	±	0.01^{f}	22	0.59	±	0.01^{c}	8	0.62	±	0.01^{cd}	8
18:1*n*–7, %	3.79	±	0.07^{b}	14	3.58	±	0.06^{ab}	22	4.76	±	0.10^{c}	8	4.66	±	0.25^{c}	8
18:1*n*–9, %	25.02	±	0.34^{d}	14	24.20	±	0.22^{cd}	22	20.73	±	0.32^{a}	8	20.69	±	0.41^{a}	8
20:1*n*–9, %	0.35	±	0.02^{ab}	14	0.32	±	0.01^{ab}	22	0.30	±	0.01^{a}	8	1.46	±	0.09^{d}	8
18:2*n*–6, %	3.14	±	0.06^{bc}	14	2.79	±	0.04^{b}	22	4.48	±	0.15^{ef}	8	1.15	±	0.04^{a}	8

20:2*n*–6, %	0.31 ± 0.01^{bc}	14	0.28 ± 0.01^{b}	22	0.51 ± 0.03^{e}	8	0.17 ± 0.01^{a}	8
18:3*n*–3, %	2.16 ± 0.04^{bcd}	14	2.12 ± 0.03^{bc}	22	2.62 ± 0.06^{ef}	8	0.93 ± 0.07^{a}	8
20:4*n*–6, %	1.22 ± 0.02^{bc}	14	1.05 ± 0.02^{b}	22	1.14 ± 0.02^{bc}	8	0.72 ± 0.02^{a}	8
20:5*n*–3, %	8.14 ± 0.17^{a}	14	8.76 ± 0.14^{ab}	22	8.46 ± 0.18^{ab}	8	8.98 ± 0.20^{abc}	8
22:5*n*–3, %	5.28 ± 0.07^{a}	14	5.69 ± 0.10^{abc}	22	5.95 ± 0.09^{bc}	8	6.57 ± 0.13^{d}	8
22:6*n*–3 (DHA), %	19.67 ± 0.22^{bc}	14	19.94 ± 0.22^{bc}	22	17.75 ± 0.47^{a}	8	17.33 ± 0.40^{a}	8
SFA, %	19.06 ± 0.18^{bcd}	14	19.13 ± 0.12^{bcd}	22	18.28 ± 0.25^{b}	8	20.72 ± 0.14^{e}	8
MUFA, %	34.67 ± 0.31^{b}	14	34.00 ± 0.27^{b}	22	33.16 ± 0.55^{ab}	8	34.15 ± 0.54^{b}	8
PUFA, %	42.81 ± 0.35^{b}	14	43.67 ± 0.32^{b}	22	45.64 ± 0.45^{cd}	8	40.04 ± 0.44^{a}	8
n–3 PUFA, %	32.48 ± 0.33^{ab}	14	33.54 ± 0.29^{bc}	22	32.93 ± 0.51^{abc}	8	31.05 ± 0.44^{a}	8
n–6 PUFA, %	4.83 ± 0.08^{cd}	14	4.24 ± 0.04^{b}	22	6.30 ± 0.16^{f}	8	2.18 ± 0.05^{a}	8

	River Dal 2016 Baltic Proper		**River Dal 2016 Gulf of Bothnia**	
Mass, kg	6.52 ± 0.43^{a}	10	5.67 ± 0.39^{a}	20
Length, cm	88.3 ± 1.8^{ab}	10	84.4 ± 1.5^{ab}	21
CF	0.94 ± 0.02^{ab}	10	0.91 ± 0.01^{ab}	20
TPP, nmol g^{-1}	0.37 ± 0.03^{ab}	10	0.29 ± 0.01^{a}	21
TMP, nmol g^{-1}	0.15 ± 0.02^{ab}	10	0.11 ± 0.01^{a}	21
THIAM, nmol g^{-1}	1.15 ± 0.37^{a}	10	0.73 ± 0.32^{a}	21
TotTH, nmol g^{-1}	1.67 ± 0.39^{a}	10	1.13 ± 0.34^{a}	21
Egg lipid, %	8.46 ± 0.28^{a}	10	8.11 ± 0.25^{a}	21
14:0, %	1.10 ± 0.03^{ab}	10	1.03 ± 0.02^{a}	21
16:0, %	10.88 ± 0.20^{a}	10	10.45 ± 0.07^{a}	21
17:0, %	0.22 ± 0.01^{bc}	10	0.21 ± 0.01^{b}	21
18:0, %	3.86 ± 0.14^{a}	10	3.72 ± 0.07^{a}	21
16:1*n*–7, %	3.96 ± 0.13^{a}	10	5.10 ± 0.10^{d}	21

17:1*n–8*, %	0.75 ± 0.01^{e}	10	0.61 ± 0.01^{cd}	21
18:1*n–7*, %	3.75 ± 0.10^{ab}	10	4.51 ± 0.07^{c}	21
18:1*n–9*, %	24.17 ± 0.22^{cd}	10	22.30 ± 0.17^{b}	21
20:1*n–9*, %	0.39 ± 0.02^{ab}	10	0.35 ± 0.01^{ab}	21
18:2*n–6*, %	2.88 ± 0.12^{b}	10	4.24 ± 0.07^{e}	21
20:2*n–6*, %	0.34 ± 0.01^{bcd}	10	0.52 ± 0.01^{e}	21
18:3*n–3*, %	2.00 ± 0.05^{b}	10	2.64 ± 0.05^{ef}	21
20:4*n–6*, %	1.24 ± 0.03^{bcd}	10	1.46 ± 0.04^{e}	21
20:5*n–3*, %	9.01 ± 0.26^{abc}	10	9.16 ± 0.13^{bc}	21
22:5*n–3*, %	5.59 ± 0.09^{ab}	10	6.10 ± 0.05^{cd}	21
22:6*n–3*, %	21.78 ± 0.49^{d}	10	18.68 ± 0.26^{ab}	21
SFA, %	17.02 ± 0.35^{a}	10	16.18 ± 0.14^{a}	21
MUFA, %	33.96 ± 0.21^{b}	10	33.78 ± 0.23^{b}	21
PUFA, %	45.97 ± 0.44^{cd}	10	47.25 ± 0.21^{d}	21
n–3 PUFA, %	35.61 ± 0.48^{d}	10	34.41 ± 0.22c^{d}	21
n–6 PUFA, %	4.58 ± 0.12^{bc}	10	6.40 ± 0.09^{f}	21

	River Simojoki 2017 Baltic Proper		**River Dal 2017 Baltic Proper**		**River Dal 2017 Gulf of Bothnia**		**River Neris 2017 Baltic Proper**	
Mass, kg	6.05 ± 0.24^{a}	17	6.82 ± 0.47^{a}	13	5.69 ± 0.46^{a}	7	9.24 ± 0.49^{b}	11
Length, cm	85.6 ± 1.0^{ab}	17	87.3 ± 1.9^{ab}	13	84.3 ± 1.5^{ab}	7	98.0 ± 1.8^{c}	11
CF	0.96 ± 0.02^{ab}	17	1.01 ± 0.02^{b}	13	0.94 ± 0.04^{ab}	7	0.97 ± 0.01^{ab}	11
TPP, nmol g^{-1}	0.50 ± 0.03^{bcd}	18	0.49 ± 0.03^{bcd}	13	0.39 ± 0.03^{ab}	7	0.55 ± 0.03^{cd}	11
TMP, nmol g^{-1}	0.22 ± 0.01^{cd}	18	0.17 ± 0.01^{abc}	13	0.11 ± 0.01^{a}	7	0.25 ± 0.02^{d}	11
THIAM, nmol g^{-1}	2.41 ± 0.41^{a}	18	2.39 ± 0.44^{a}	13	0.74 ± 0.56^{a}	7	5.26 ± 0.84^{b}	11
TotTH, nmol g^{-1}	3.12 ± 0.44^{a}	18	3.05 ± 0.48^{a}	13	1.23 ± 0.60^{a}	7	6.06 ± 0.87^{b}	11
Egg lipid, %	8.48 ± 0.14^{a}	18	8.90 ± 0.13^{ab}	13	8.55 ± 0.22^{ab}	7	9.96 ± 0.39^{bc}	11

14:0, %	1.22 ± 0.03^{ab}	18	1.27 ± 0.05^{b}	13	1.20 ± 0.06^{ab}	7	1.29 ± 0.02^{b}	11
16:0, %	12.62 ± 0.14^{cd}	18	12.00 ± 0.16^{bc}	13	11.85 ± 0.27^{b}	7	12.37 ± 0.19^{bc}	11
17:0, %	0.27 ± 0.01^{e}	18	0.27 ± 0.01^{de}	13	0.24 ± 0.01^{cd}	7	0.27 ± 0.00^{de}	11
18:0, %	4.76 ± 0.06^{c}	18	4.51 ± 0.09^{bc}	13	4.46 ± 0.18^{bc}	7	4.47 ± 0.09^{bc}	11
16:1*n*–7, %	4.15 ± 0.07^{ab}	18	4.05 ± 0.09^{ab}	13	4.53 ± 0.05^{bc}	7	4.31 ± 0.13^{ab}	11
17:1*n*–8, %	0.46 ± 0.01^{b}	18	0.41 ± 0.01^{b}	13	0.34 ± 0.02^{a}	7	0.43 ± 0.01^{b}	11
18:1*n*–7, %	3.32 ± 0.04^{a}	18	3.31 ± 0.10^{a}	13	3.73 ± 0.11^{ab}	7	3.67 ± 0.13^{ab}	11
18:1*n*–9, %	24.62 ± 0.20^{cd}	18	24.44 ± 0.31^{cd}	13	23.50 ± 0.68^{bc}	7	22.05 ± 0.32^{ab}	11
20:1*n*–9, %	0.43 ± 0.02^{abc}	18	0.53 ± 0.04^{c}	13	0.44 ± 0.02^{bc}	7	0.40 ± 0.02^{abc}	11
18:2*n*–6, %	3.37 ± 0.06^{cd}	18	3.57 ± 0.08^{d}	13	4.67 ± 0.10^{f}	7	3.42 ± 0.07^{cd}	11
20:2*n*–6, %	0.34 ± 0.01^{bcd}	18	0.40 ± 0.01^{d}	13	0.60 ± 0.03^{f}	7	0.35 ± 0.01^{cd}	11
18:3*n*–3, %	2.21 ± 0.04^{bcd}	18	2.31 ± 0.07^{cd}	13	2.79 ± 0.18^{f}	7	2.41 ± 0.05^{de}	11
20:4*n*–6, %	1.14 ± 0.03^{bc}	18	1.32 ± 0.05^{cde}	13	1.41 ± 0.09^{de}	7	1.27 ± 0.03^{cd}	11
20:5*n*–3, %	8.97 ± 0.15^{abc}	18	9.18 ± 0.17^{bc}	13	9.20 ± 0.30^{bc}	7	9.81 ± 0.17^{c}	11
22:5*n*–3, %	5.83 ± 0.10^{bc}	18	5.59 ± 0.10^{ab}	13	5.65 ± 0.16^{abc}	7	5.32 ± 0.10^{a}	11
22:6*n*–3, %	19.54 ± 0.28^{bc}	18	20.00 ± 0.36^{bc}	13	17.80 ± 0.41^{a}	7	20.92 ± 0.30^{cd}	11
SFA, %	19.96 ± 0.17^{de}	18	19.09 ± 0.23^{bcd}	13	18.64 ± 0.45^{bc}	7	19.59 ± 0.24^{cd}	11
MUFA, %	34.02 ± 0.22^{b}	18	33.73 ± 0.32^{b}	13	33.59 ± 0.71^{ab}	7	31.95 ± 0.26^{a}	11
PUFA, %	44.57 ± 0.31^{bc}	18	45.67 ± 0.50^{cd}	13	46.52 ± 0.54^{d}	7	47.05 ± 0.38^{d}	11
n–3 PUFA, %	39.45 ± 0.31^{e}	18	40.02 ± 0.49^{ef}	13	39.35 ± 0.49^{e}	7	41.80 ± 0.42^{f}	11
n–6 PUFA, %	5.04 ± 0.06^{d}	18	5.55 ± 0.10^{e}	13	7.01 ± 0.10^{g}	7	5.16 ± 0.06^{de}	11

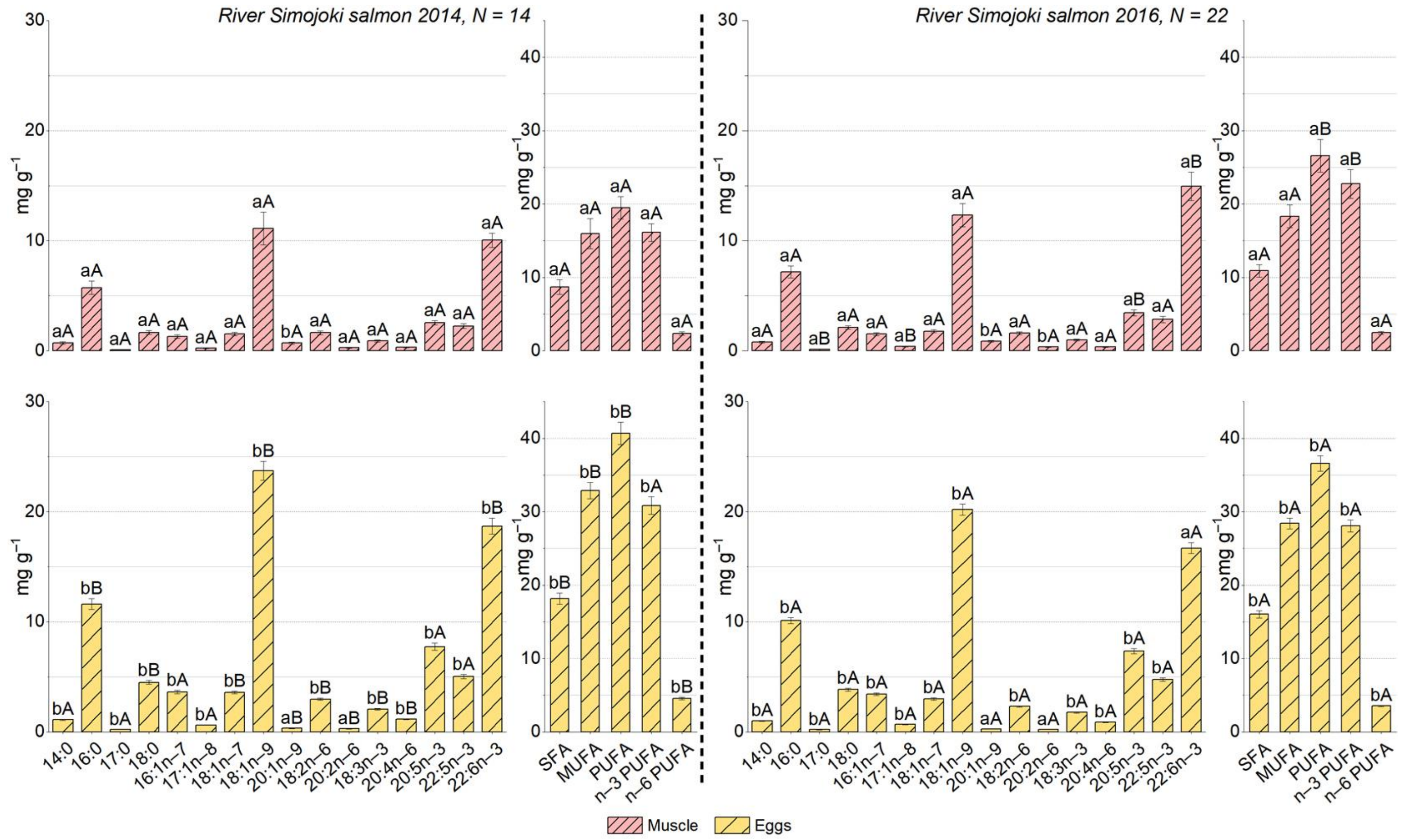
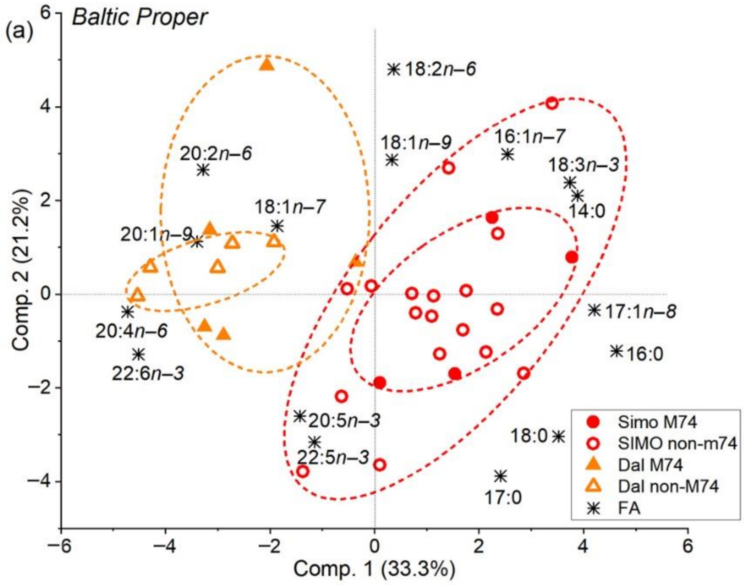
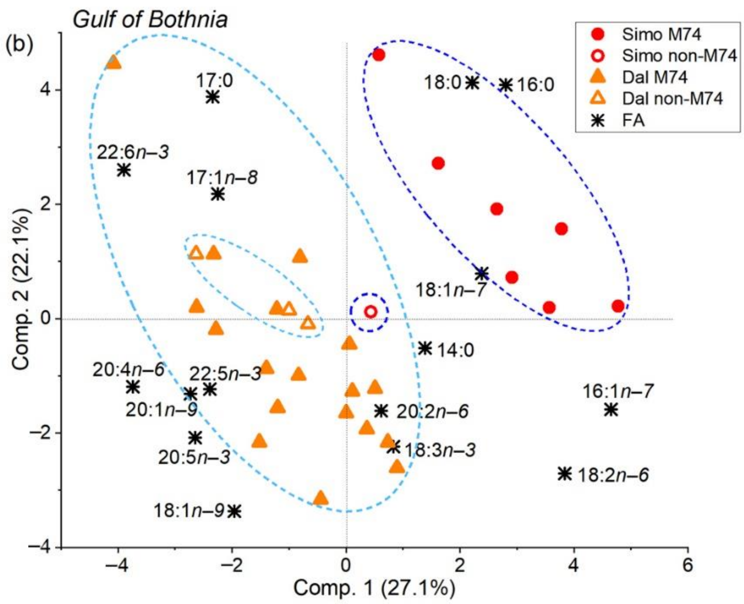


Figure S1. Mean (± SE) fatty acid (FA) concentrations with sums of FA structural classes in the muscle and unfertilized eggs of salmon ascending the River Simojoki in 2014 and 2016 and that had been feeding in the Baltic Proper. Different lower-case letters indicate a significant ($p < 0.05$) difference in the FA concentrations between muscle and eggs in either year (vertical comparison), and an upper-case letter a significant ($p < 0.05$) difference between 2014 and 2016 in either muscle or eggs (horizontal comparison). The number of observations (N) is indicated.



SIMCA classification: x = p < 0.05, - = non-significant			
	Simo non-M74	Simo M74	Dal non-M74
Simo M74	-		
Dal non-M74	-	x	
Dal M74	-	x	-



SIMCA classification: x = p < 0.05, - = non-significant			
	Simo non-M74	Simo M74	Dal non-M74
Simo M74			
Dal non-M74		x	
Dal M74		x	-

Figure S2. Biplots based on PCA for the proportions of fatty acids (FAs) in the eggs of 2nd sea-year salmon in the fall of 2016 from the River Simojoki (Simo) and River Dal (Dal) from **a**) the Baltic Proper and **b**) the Gulf of Bothnia. Salmon were grouped (circled) into M74 females or non-M74 females based on the free thiamine (THIAM) concentration < 0.71 and > 0.71 nmol g^{-1} (Vuorinen et al., 2021) respectively in unfertilized eggs. The SIMCA test results for the pairs of circled groups are given in the table for the groups with $N > 2$.

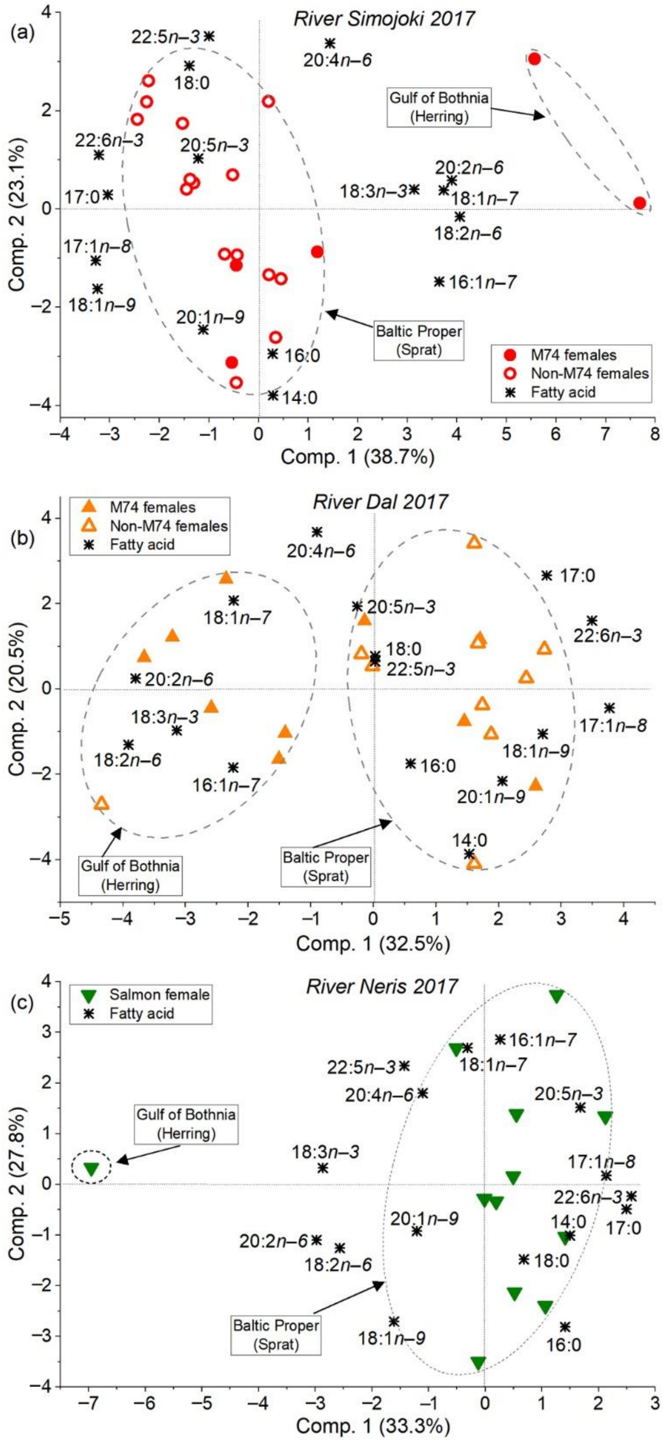
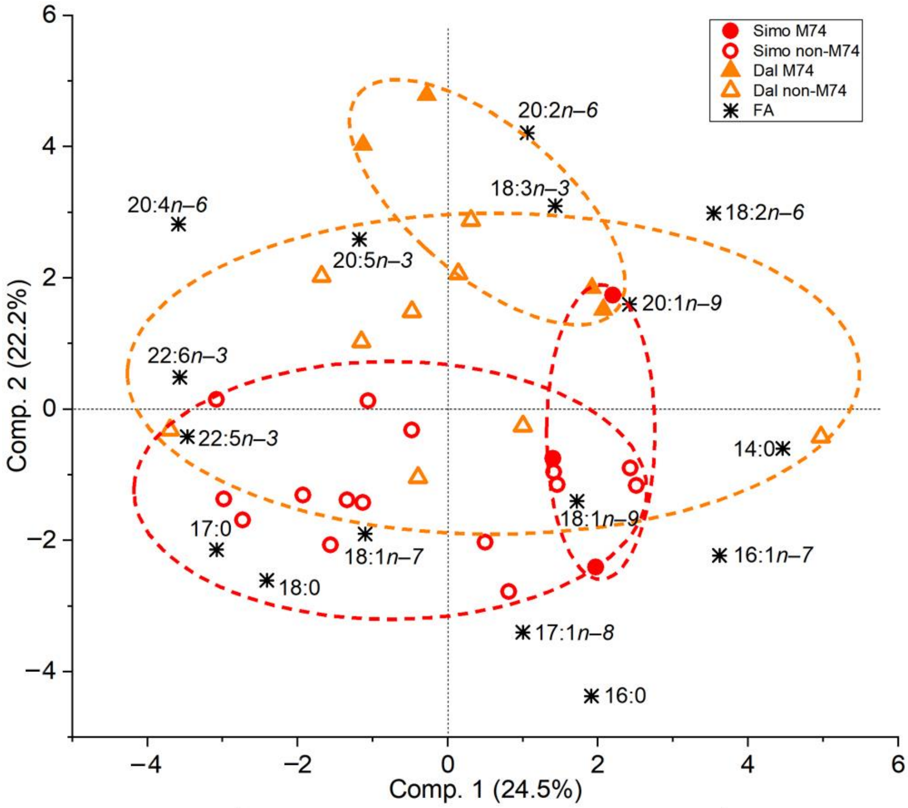


Figure S3. Biplot based on PCA for the proportions of fatty acids (FAs) in unfertilized eggs of 2nd sea-year Baltic salmon in the fall of 2017 from **a**) the River Simojoki ($N = 20$), **b**) the River Dal ($N = 20$), and **c**) the River Neris ($N = 12$). Salmon were grouped (circled) according to the FA signatures to the two feeding areas, the Baltic Proper or the Gulf of Bothnia, and marked as M74 females or non-M74 females according to the free thiamine (THIAM) concentration < 0.7 and > 0.7 nmol g^{-1} (Vuorinen et al., 2021) respectively in unfertilized eggs. The circled groups in a) and b) differed significantly ($p < 0.01$) in the SIMCA test.



SIMCA classification: x = p < 0.05, - = non-significant			
	Simo non-M74	Simo M74	Dal non-M74
Simo M74	-		
Dal non-M74	-	-	
Dal M74	x	x	-

Figure S4. Biplot based on PCA for the proportions of fatty acids (FAs) in the eggs of 2nd sea-year salmon in the fall of 2017 from the River Simojoki (Simo) and River Dal (Dal) from the Baltic Proper. Salmon were grouped (circled) into M74 females or non-M74 females based on the free thiamine (THIAM) concentration < 0.71 and > 0.71 nmol g^{-1} (Vuorinen et al., 2021) respectively in unfertilized eggs. The SIMCA test results for the pairs of circled groups are given in the table for the groups with $N > 2$.

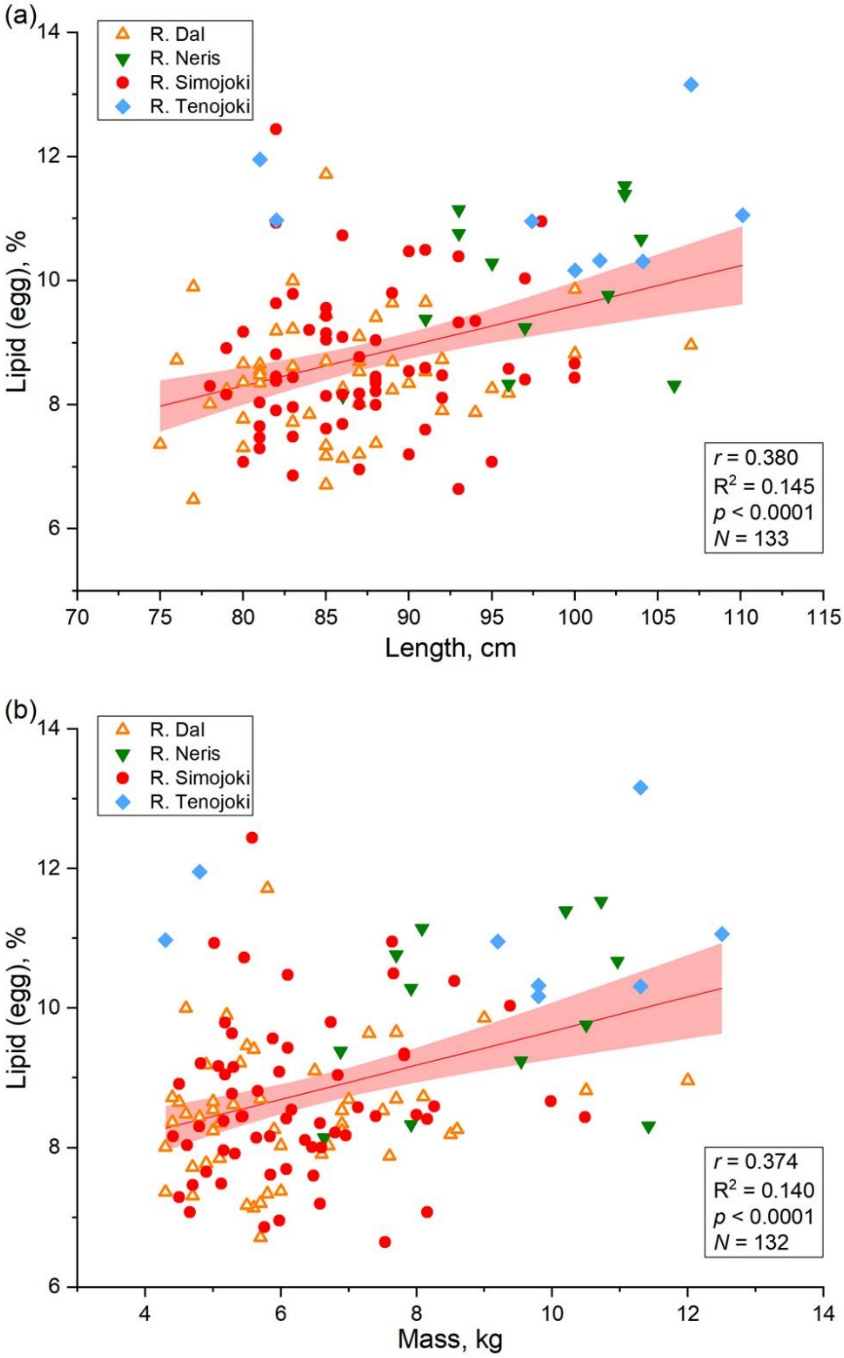


Figure S5. Linear models with 95% confidence bands for the correlations of lipid content in unfertilized eggs with **a**) total length and **b**) body mass of salmon females of the Rivers Simojoki, Dal, Neris, and Tenojoki. The correlation coefficient, coefficient of determination, significance, and the number of observations are given.

References

Vuorinen, P.J.; Rokka, M.; Nikonen, S.; Juntunen, E.-P.; Ritvanen, T.; Heinimaa, P.; Keinänen, M. Model for estimating thiamine deficiency-related mortality of Atlantic salmon (*Salmo salar*) offspring and variation in the Baltic salmon M74 syndrome. *Mar. Freshw. Behav. Phy.* **2021**, *54*, 97-131, https://doi.org/10.1080/10236244.2021.1941942.