



Supplementary Materials

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Reduced Numbers of Returning Atlantic Salmon (*Salmo salar*) and Thiamine
Deficiency Are both Associated with the Consumption of High-Lipid Prey Fish

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Table S1. Linear model parameters (intercept, slope, R^2 = coefficient of determination, and F and p values) and Pearson correlation coefficients (r) for the relationships of the numbers of multi-sea-winter salmon (*Salmo salar*) (y) returning to the Rivers Tornionjoki and Simojoki in 2012–2023, and the numbers of herring (*Clupea harengus*) (H) and sprat (*Sprattus sprattus*) (S) in various age combinations in the Baltic Proper two years earlier (2010–2021). $N = 12$, the number of salmon return years for all. Statistically significant ($p < 0.05$) correlations are in bold.

x	y	Intercept	Slope	R^2	$F_{1,10}$	p	r
<i>River Tornionjoki</i>							
0-y-old H	y	4.056	0.555	0.445	8.006	0.018	0.667
0–1-y-old H	y	3.649	0.726	0.306	4.402	0.062	0.553
0-y-old S	y	3.116	0.713	0.457	8.427	0.016	0.676
0–1-y-old S	y	2.932	0.728	0.238	3.129	0.107	0.488
0–2-y-old S	y	2.846	0.735	0.141	1.641	0.229	0.375
0–3-y-old S	y	2.783	0.748	0.133	1.532	0.244	0.365
1–2-y-old S	y	7.079	-1.096	0.379	6.106	0.033	-0.616
1–3-y-old S	y	7.929	-1.429	0.434	7.683	0.020	-0.659
1–4-y-old S	y	7.970	-1.422	0.363	5.690	0.038	-0.602
S tot minus 0-y-olds	y	8.580	-1.664	0.394	6.51	0.029	-0.628
S tot	y	2.057	1.016	0.184	2.26	0.164	0.429
0-y-old H + 0-y-old S	y	3.082	0.716	0.468	8.800	0.014	0.684
0-y-old H + 0–2-y-old S	y	2.739	0.771	0.168	2.017	0.186	0.410
0-y-old H + 1-y-old S	y	5.036	-0.168	0.016	0.165	0.694	-0.127
0-y-old H + 1–2-y-old S	y	7.055	-1.060	0.231	2.996	0.114	-0.480
0-y-old H + 1–3-y-old S	y	7.913	-1.396	0.275	3.791	0.080	-0.524
<i>River Simojoki</i>							
0-y-old H	y	3.107	0.313	0.326	4.841	0.052	0.571
0–1-y-old H	y	3.097	0.257	0.088	0.969	0.348	0.297
0-y-old S	y	2.420	0.473	0.464	8.674	0.015	0.682
0–1-y-old S	y	2.721	0.308	0.099	1.095	0.320	0.314
0–2-y-old S	y	2.347	0.445	0.119	1.354	0.272	0.345
0–3-y-old S	y	2.128	0.524	0.150	1.768	0.213	0.388
1–2-y-old S	y	5.350	-0.866	0.547	12.052	0.006	-0.739
1–3-y-old S	y	5.678	-0.977	0.469	8.830	0.014	-0.685
1–4-y-old S	y	5.769	-0.999	0.414	7.054	0.024	-0.643
S tot minus 0-y-olds	y	6.268	-1.199	0.473	8.99	0.013	-0.688
S tot	y	1.626	0.709	0.207	2.61	0.137	0.455
0-y-old H + 0-y-old S	y	2.415	0.467	0.460	8.521	0.015	0.678
0-y-old H + 0–2-y-old S	y	2.295	0.462	0.139	1.618	0.232	0.373
0-y-old H + 1-y-old S	y	4.254	-0.389	0.200	2.505	0.145	-0.448
0-y-old H + 1–2-y-old S	y	5.451	-0.892	0.376	6.031	0.034	-0.613
0-y-old H + 1–3-y-old S	y	5.679	-0.960	0.300	4.284	0.065	-0.548

Table S2. The number of multi-sea-winter (MSW) salmon (*Salmo salar*) ascendants of the Rivers Tornionjoki and Simojoki from 2012 to 2023, and the mean concentration of free thiamine (egg THIAM, nmol g⁻¹) in unfertilized eggs of salmon from Tornionjoki and Simojoki and numbers of 0-year-old herring (*Clupea harengus*) and 1–2-year-old and 1–3-year-old sprat (*Sprattus sprattus*) in the Baltic Proper in 2010–2021. The ratios of 1–2-year-old (S1–2) and 1–3-year-old sprat (S1–3) to 0-year-old herring (H0) are also given. Data from the International Council for the Exploration of the Sea [1,41,56,60].

Year Salmon/prey	MSW salmon		Egg THIAM	Number of Herring 0-y x10 ⁹	Number of Sprat		Ratios	
	Tornio	Simo			1–2-y x10 ⁹	1–3-y x10 ⁹	S1–2/H0	S1–3/H0
2012/2010	52,828	2751	3.901	8.9	161	182	18.2	20.6
2013/2011	46,580	2544	4.336	23.5	121	183	5.1	7.8
2014/2012	92,167	3322	5.847	21.5	136	151	6.3	7.0
2015/2013	45,456	2549	3.206	14.3	140	160	9.8	11.2
2016/2014	91,137	5125	1.883	51.9	105	133	2.0	2.6
2017/2015	36,409	1642	2.105	12.5	275	299	21.9	23.9
2018/2016	35,866	3231	3.922	14.3	208	229	14.5	16.0
2019/2017	52,738	3749	3.625	14.7	119	210	8.1	14.3
2020/2018	56,716	3707	3.663	8.6	139	169	16.1	19.6
2021/2019	82,796	3554	4.599	19.1	122	146	6.4	7.7
2022/2020	47,777	2888	3.771	7.9	150	180	19.0	22.7
2023/2021	16,020	1819		6.4	179	204	28.1	32.0
Average	54,708	3073	3.714	17.0	155	187	13.0	15.4

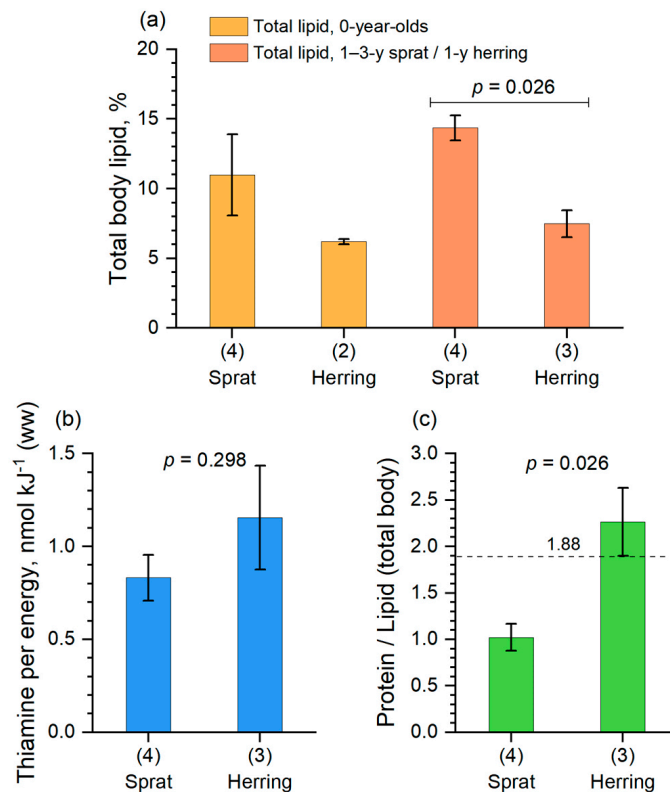


Figure S1. The mean ($\pm$ SE) (a) total body lipid content of 0-year-old sprat (*Sprattus sprattus*) and herring (*Clupea harengus*) from the Baltic Proper in the fall of 2017 [Data from 62] and of 1-3-year-old sprat and 1-year-old herring from the Baltic Proper in the fall of 1994 and 2003 [Data from 12,43,45], and (b) the ratio of total thiamine concentration to the unit of energy, and (c) the ratio of total protein concentration to lipid content of 1-3-year-old sprat and 1-year-old herring from the Baltic Proper. The p -values for the Wilcoxon test between the mean values of sprat and herring for the parameters are shown. The dashed line indicates the optimal protein-to-lipid ratio for salmon (*Salmo salar*) post-smolts [28]. The number of observations is given in parentheses below the x-axis.

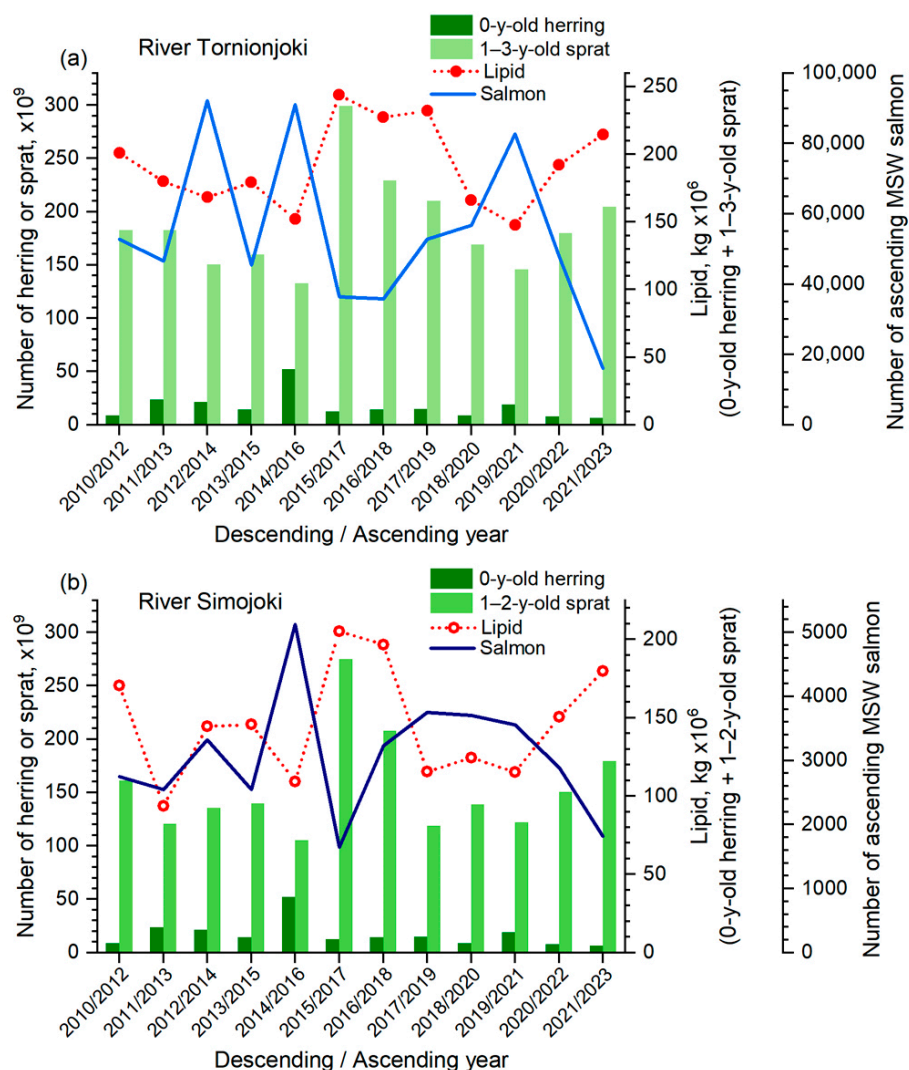


Figure S2. The number of herring (*Clupea harengus*) and sprat (*Sprattus sprattus*) in the Baltic Proper when salmon (*Salmo salar*) post-smolts arrived there in 2010–2021 (descending year), and number of multi-sea-winter (MSW) salmon of (a) the River Tornionjoki that returned to their home river in 2012–2023 (ascending year), and the amount of lipid available from 0-year-old herring and 1–3-year-old sprat and (b) the number of MSW salmon of the River Simojoki and the amount of lipid available from 0-year-old herring and 1–2-year-old sprat.

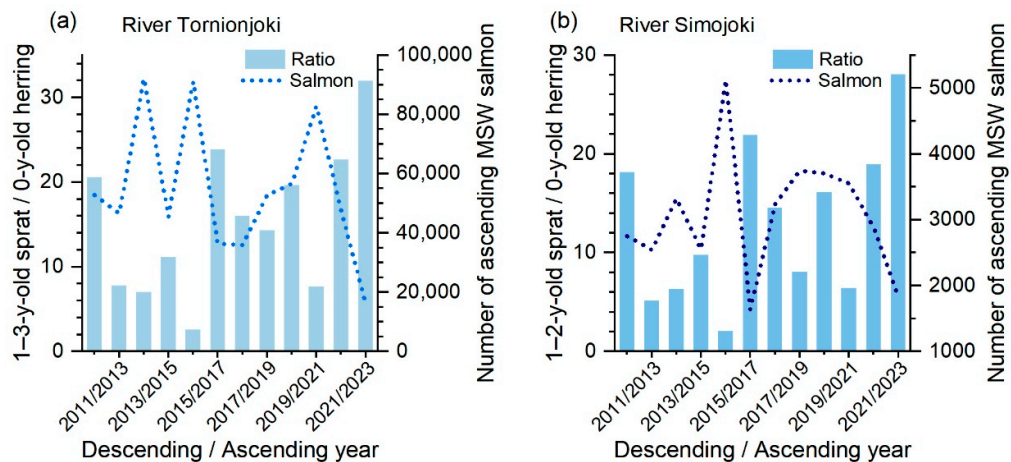


Figure S3. The number of multi-sea-winter (MSW) salmon (*Salmo salar*) of (a) the River Tornionjoki and (b) the River Simojoki that returned to their home river in 2012–2023 and ratio of the number of youngish sprat (*Sprattus sprattus*) to 0-year-old herring (*Clupea harengus*) (1–3-year-old sprat for River Tornionjoki salmon and 1–2-year-old sprat for River Simojoki salmon) two years earlier (2010–2021) in the Baltic Proper