Supplementary information to 'Population niche breadth and individual trophic specialisation of fish along a climate-productivity gradient'

Javier Sánchez-Hernández, Brian Hayden, Chris Harrod and Kimmo K. Kahilainen

List of items in the supplementary:

-Appendix 1: Detailed information about the study area.

-Appendix 2: Principal Component Analysis (PCA): climate-productivity index (CP_i) and lake morphometry index (M_i)

-Appendix 3: Information about size, gill raker count and gill raker length of whitefish morphs.

-**Appendix 4**: List of invertebrate taxa present in the environment (pelagic, littoral and profundal) and stomachs.

-Appendix 5: Correlation (Pearson's) table showing the relationship between individual and populational feeding (individual trophic specialisation and Levins' index, respectively) and potential predictors (environmental status, ecological opportunity, total CPUE, species-specific CPUE, fish richness and predation risk).

-Appendix 6: Residual plot of the best models explaining the variation in feeding of fish species.

-Appendix 7: Patterns in resource availability (zooplankton and littoral macroinvertebrates densities) and fish abundance along climate-productivity gradients (CP_i).

Appendix 1. Detailed information about the study area.

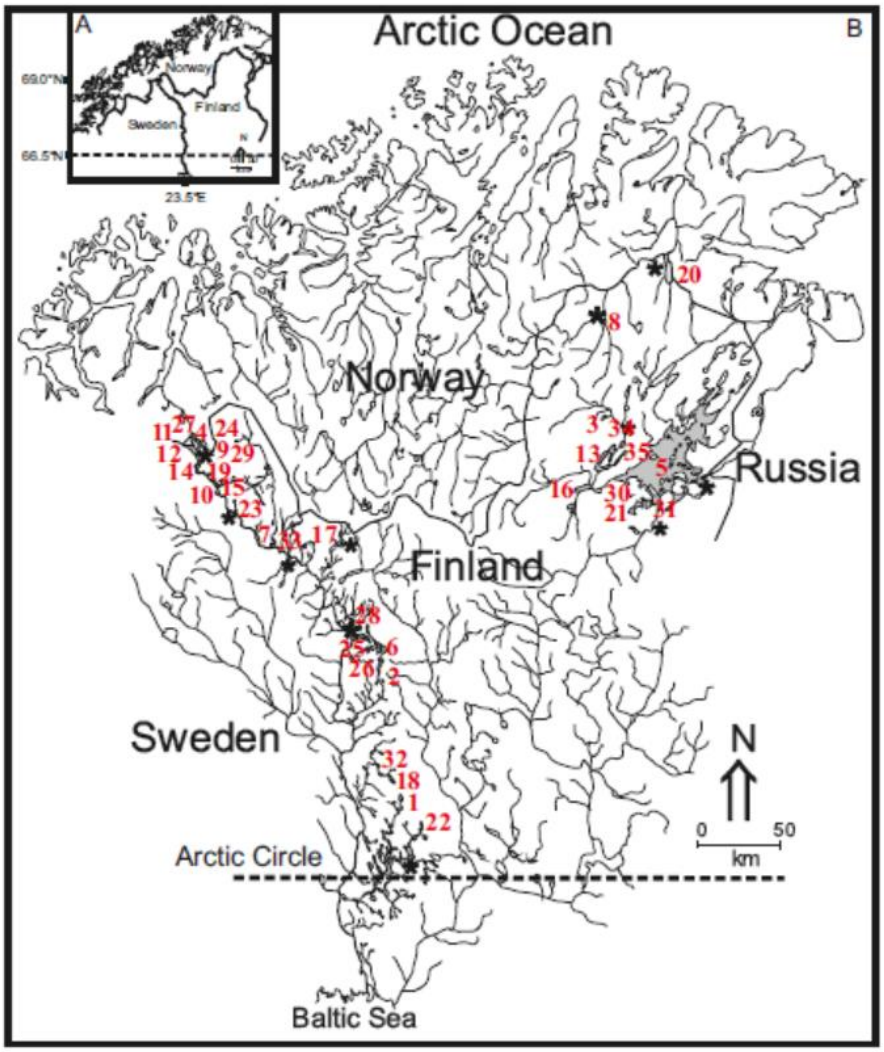

Figure 1A. Northern Fennoscandia showing (A) the study region and (B) the location of the 35 lakes in Finnish Lapland used in this study. Red numbers refer to lake number shown in Table 1A.

Table 1A. Information about the lakes included in this study. Location: longitude (°E) and latitude (°N). Fish species abbreviations are: LSR=large sparsely rakered whitefish; *Coregonus lavaretus*, DR=densely rakered whitefish, LDR=large densely rakered whitefish, SSR=small sparsely rakered whitefish, Ve=vendace; *Coregonus albula*, Hyb=LSR x vendace hybrid, PWf=peled whitefish; *Coregonus peled*, Bt=brown trout; *Salmo trutta*, Ac=Arctic charr; *Salvelinus alpinus*, Gr=grayling; *Thymallus thymallus*, Lt=lake trout; *Salvelinus namaycush*, Lls=land-locked salmon, *Salmo salar* m. *sebago*, As=Atlantic salmon; *Salmo salar*, Pi=pike; *Esox lucius*, Bu=burbot; *Lota lota*, Pe=perch; *Perca fluviatilis*, Ru=ruffe; *Gymnocephalus cernua*, Ab=alpine bullhead, *Cottus poecilopus*, Cs=common sculpin, *Cottus gobio*, Mi=minnow; *Phoxinus phoxinus*, Ro=roach; *Rutilus rutilus*, Bl=bleak; *Alburnus alburnus*, Id=Ide; *Leuciscus idus*, Da=Dace; *Leuciscus leuciscus*, Sm=smelt; *Osmerus eperlanus*, 9sp=nine-spined stickleback; *Pungitius pungitius*, 3sp=three-spined stickleback; *Gasterosteus aculeatus*, Fl=flounder; *Platichthys flesus*.

Lake no	Lake	Altitude (m a.s.l.)	Longitude (º)	Latitude (º)	Fish richness	Fish fauna
1	Aalis	177	24.32	67	9	Ve,Pi,Bu,Pe,Ru,Cs,Mi,Ro,Bl
2	Akas	263	24.07	67.49	8	LSR,Ve,Hyb,Pi,Bu,Pe,Ru,Ro,9sp
3	Aksu	206	26.53	69.14	8	LSR,Bt,Gr,Pi,Bu,Pe,Mi,9sp
4	Galggo	501	20.46	69.07	2	Ac,Bu
5	Inari	118	27.84	69.05	13	LSR,DR,SSR,LDR,Ve,Hyb,Bt,Ac,Gr,Lt,Lls,Pi,Bu,Pe,Mi,9sp,3sp
6	Jeris	258	24.06	67.55	9	LSR,Ve,Pi,Bu,Pe,Ru,Cs,Mi,9sp
7	Kelotti	368	22	68.31	8	LSR,Gr,Pi,Bu,Pe,Ru,Ab,Mi
8	Kevo	75	27	69.45	9	LSR, DR, SSR,Bt,Gr,As,Pi,Bu,Mi,9sp,3sp
9	Kilpis	473	20.49	69.03	8	LSR, Bt,Ac,Gr,Pi,Bu,Ab,Mi
10	Kivi	445	21.15	68.49	9	LSR,Bt,Gr,Pi,Bu,Pe,Ru,Ab,Mi
11	Kolta	490	20.3	69.03	6	LSR,Gr,Pi,Bu,Ab,Mi,
12	Kuohkima	489	20.33	69.03	6	LSR,Gr,Pi,Bu,Ab,Mi,

13	Muddus	146	26.5	69	10	LSR,DR,SSR, LDR,Bt,Ac,Gr,Pi,Bu,Pe,Mi,9sp,3sp
14	Mukka	458	20.59	68.54	9	LSR,Bt,Gr,Pi,Bu,Ru,Ab,Mi,Id
15	Oiko	448	21.13	68.5	9	LSR,Gr,Pi,Bu,Pe,Ru,Ab,Mi,Ro,
16	Paadar	144	26.54	68.86	9	LSR,DR,SSR,LDR,Bt,Gr,Pi,Bu,Pe,Mi,9sp,3sp
17	Palo	346	23.21	68.34	8	LSR,Ve,Pi,Bu,Pe,Ru,Cs,Ro
18	Pasma	164	24.22	67.07	8	LSR,Ve,Pi,Pe,Ru,Ro,Bl,Id
19	Peera	459	21.08	68.88	9	LSR,Bt,Gr,Pi,Bu,Pe,Ru,Ab,Mi
20	Pulmanki	12	27.99	69.98	9	LSR,DR,SSR,Bt,Ac,Gr,As,Cs,9sp,3sp,Fl
21	Raha	132	27.17	68.45	11	LSR,Ve,Hyb,Bt,Ac,Gr,Pi,Bu,Pe,Mi,9sp,3sp
22	Rattos	118	24.52	66.5	8	LSR,Ve,Pi,Pe,Ru,Ro,Bl,Sm
23	Ropi	399	21.35	68.41	11	LSR,DR,Bt,Gr,Pi,Bu,Pe,Ru,Ab,Mi,Ro,Id
24	Saana	679	20.87	69.05	2	Ac,Bt
25	Sarki	261	23.58	67.54	6	LSR,Ve,Hyb,Pi,Bu,Pe,Ru,
26	Sarkilompolo	255	23.54	67.54	8	LSR,Ve,PWf,Hyb,Pi,Bu,Pe,Ru,Ro
27	Siilas	484	20.74	69.07	6	LSR,Bt,Gr,Pi,Bu,Ab
28	Toras	247	23.52	67.58	10	LSR,Ve,Hyb,Pi,Bu,Pe,Ru,Mi,Ro,Bl,9sp
29	Tsahkal	559	20.55	69.01	4	LSR,Bt,Ac,Bu
30	Tuulis	302	28.91	69.45	2	Bt,Ac
31	Ukko	119	27.47	68.76	11	LSR,LDR,Ve,Hyb,Bt,Ac,Gr,Pi,Bu,Pe,Mi,9sp,3sp
32	Vaatto	156	24.22	67.12	8	LSR,Ve,Pi,Pe,Ru,Ro,Bl,Id
33	Vaggoval	331	22.14	68.3	7	LSR,Pi,Pe,Ru,Mi,Ro,Da
34	Vastus	146	27.07	69.03	9	LSR,DR,Bt,Gr,Pi,Bu,Pe,Mi,9sp,3sp
35	Vuontis	151	27.04	69	9	LSR,Bt,Gr,Pi,Bu,Pe,Mi,9sp,3sp

Appendix 2. Principal Component Analysis (PCA): climate-productivity index (CP_i) and lake morphometry index (M_i).

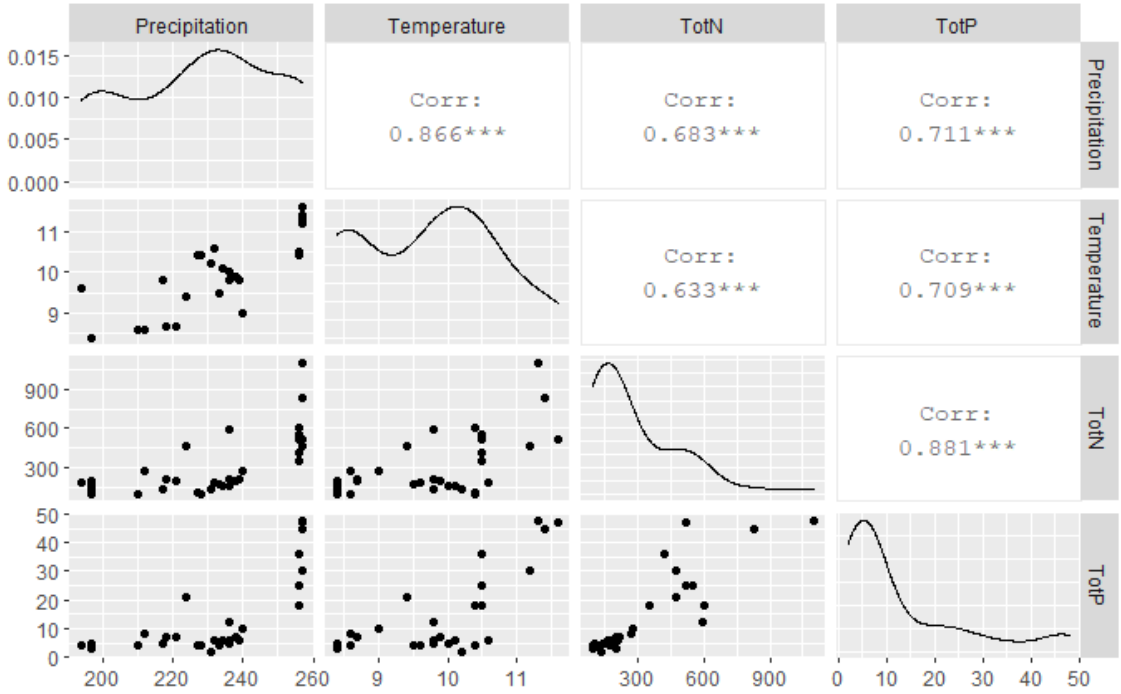

Figure 2A. Summary plots outlining co-linearity between precipitation (precip), temperature (temp), total nitrogen (TN) and total phosphorus (TP) among lakes. Scatter plots are presented in the lower left section and related Pearson correlation coefficients in the upper right section. Density distributions of each environmental measurement are presented in the centre.

Climate-productivity index (CP_i)

PCA of the collinear variables, with PC1 explaining 81% of variability in environmental variables associated with each lake (names used as markers). PC1 was used to infer variation in climate and productivity index (i.e. the Climate-Productivity index, CP_i) in subsequent analyses.

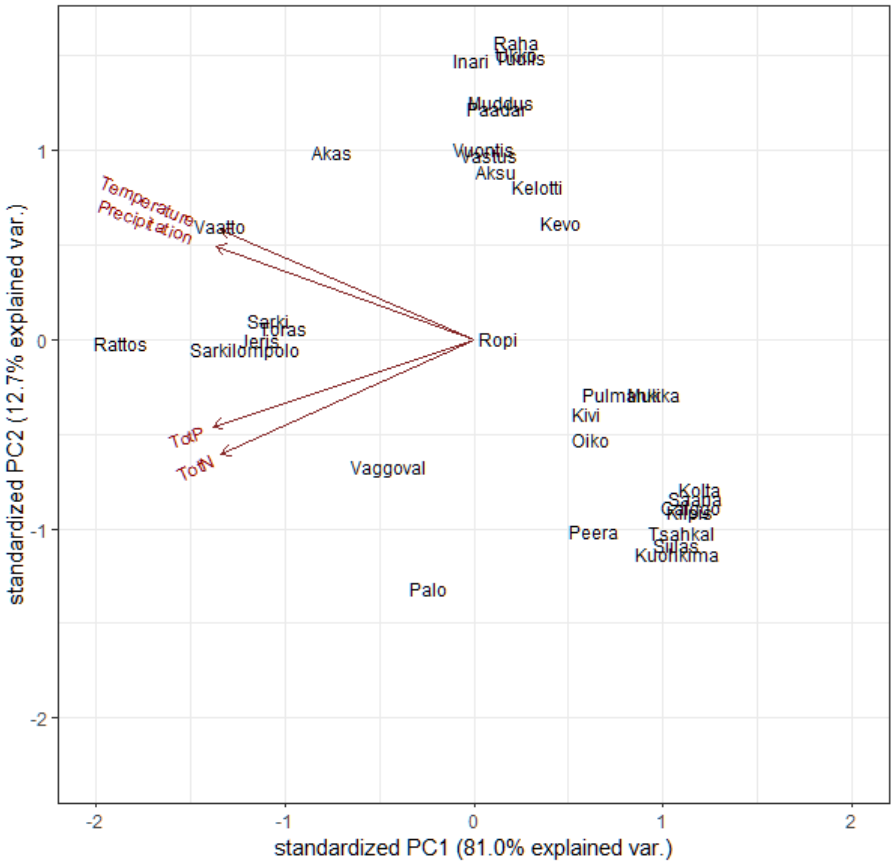

Figure 2B. Principal Component Analysis (PCA) based on environmental variables (climate and productivity).

Lake morphometry index (M_i)

PCA of the collinear variables, with PC1 explaining 54.6% of variability in environmental variables and being used to infer variation in lake morphometry index (i.e. the Morphometry index, M_i) in subsequent analyses.

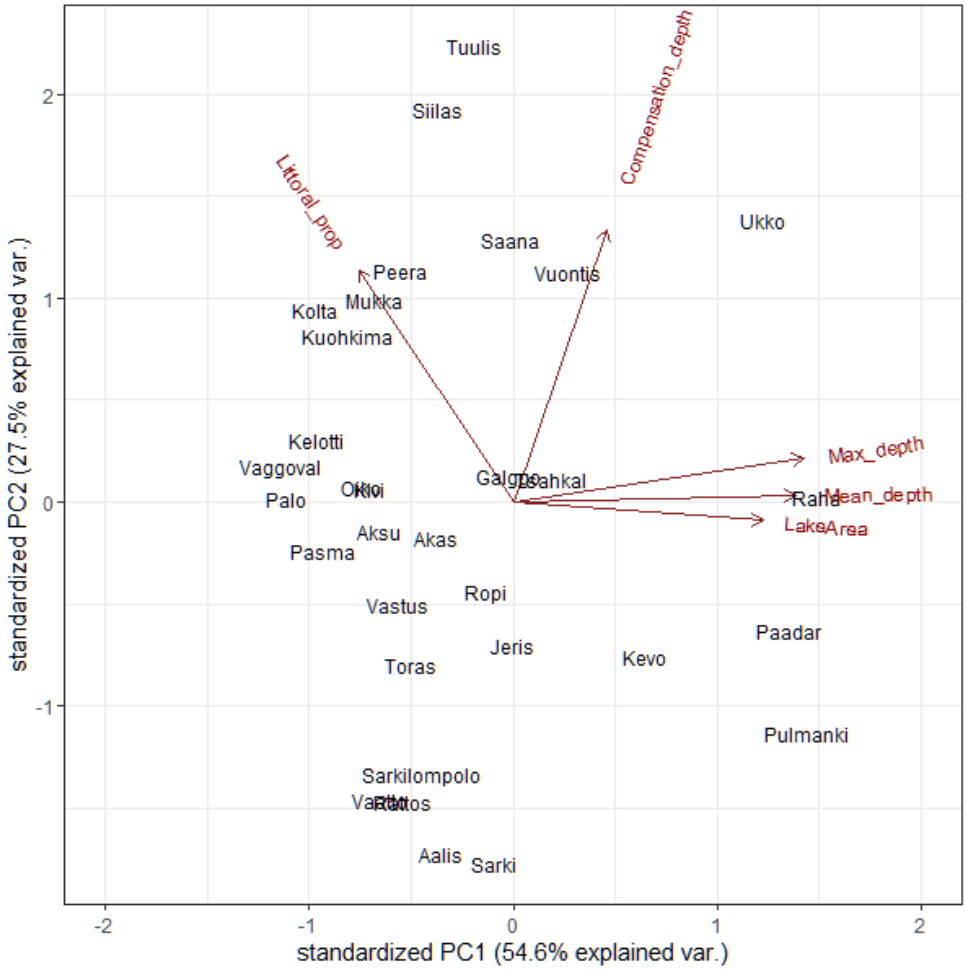

Figure 2C. Principal Component Analysis (PCA) based on morphology lake variables.

Appendix 3. Information about size, gill raker count and gill raker length of whitefish morphs.

Table 3A. Information about size, gill raker count (first left gill arch) and gill raker length (middle longest raker length) of whitefish morphs (mean value and range in brackets). LSR = large sparsely rakered, LDR = large densely rakered whitefish, DR = densely rakered, SSR = profundal small sparsely rakered, and Hybrid = whitefish × vendace hybrids. '—' no data.

Lake	Lake type	Morph	Total length (cm)	Gill raker count	Gill raker length (mm)
Akas	Monomorphic	Hybrid	21.3 (12.-30.5)	37.3 (32-46)	5.42 (2.8-6.8)
		LSR	23.9 (9.4-30.2)	29.4 (24-36)	3.16 (1.5-5.4)
Aksu	Monomorphic	LSR	21.7 (13.8-42.5)	24.4 (21-28)	3.48 (1.9-6.2)
Inari	Polymorphic	DR	13.3 (6.1-20.4)	34.9 (22-40)	3.57 (1.60-5.40)
		LDR	28.3 (15.80-35.0)	32.1 (28-41)	5.26 (3.4-6.7)
		LSR	23.3 (10.9-39.2)	22.8 (18-32)	3.12 (1.8-7.5)
		SSR	20.6 (12.80-27.90)	18.9 (15-28)	3.12 (1.4-4.7)
Jeris	Monomorphic	LSR	21.7 (15.3-31.8)	25.9 (22-34)	3.19 (2.2-6.0)
Kelotti	Monomorphic	LSR	21.2 (8.1-38.9)	26.6 (23-32)	3.02 (1.2-6.0)
Kevo	Polymorphic	DR	16.0 (8.5-25)	31.0 (25-39)	2.82 (1.1-5.2)
		LSR	20.7 (10.1-32.7)	28.0 (24-39)	2.61 (1.4-3.7)
		SSR	21.7 (17.2-26.9)	28.0 (23-31)	2.80 (1.8-5.0)
Kilpis	Monomorphic	LSR	24.3 (7-59.8)	23.9 (19-30)	2.99 (1.4-6.1)
Kivi	Monomorphic	LSR	17.8 (7.8-40.3)	29.3 (25-35)	3.53 (1.9-8.8)
Kolta	Monomorphic	LSR	22.8 (14.9-52.4)	27.6 (24-32)	2.94 (1.7-5.3)
Kuohkima	Monomorphic	LSR	27.8 (8.3-57.8)	25.8 (20-31)	3.40 (1.3-5.7)
Muddus	Polymorphic	DR	12.5 (5.1-28.2)	34.8 (21-43)	4.43 (3.9-5.2)
		LDR	27.7 (19.2-33-3)	33.7 (29-39)	6.3 (4.4-8.1)
		LSR	21.2 (6.9-42.1)	23.1 (20-30)	—
		SSR	15.8 (7.9-32.1)	16.9 (13-21)	—
Mukka	Monomorphic	LSR	16.6 (9.2-37.5)	27.3 (24-31)	2.71 (1.6-5.9)
Oiko	Monomorphic	LSR	17.9 (7.9-36.1)	29.3 (23-35)	3.12 (1.6-5.39
Paadar	Polymorphic	DR	11.4 (6.1-33.1)	35.0 (31-42)	3.06 (1.2-7.0)
		LDR	30.0 (21.6-34.1)	33.4 (26-38)	6.12 (4.1-7.6)
		LSR	20.9 (11.8-33.5)	24.5 (20-33)	2.81 (1.6-4.8)
		SSR	18.7 (11-29.8)	18.3 (15-21)	2.37 (1.4-4.3)
Palo	Monomorphic	LSR	33.9 (10.4-52.8)	29.8 (24-36)	5.22 (1.5-8.5)
Pasma	Monomorphic	LSR	21.1 (12-31.2)	30.9 (25-35)	4.07 (1.8-5.7)
Peera	Monomorphic	LSR	20.6 (12.9-37.5)	31.9 (22-38)	4.09 (2.6-6.5)
Pulmanki	Polymorphic	DR	23.2 (12.8-26.7)	40.1 (36-46)	5.24 (2.5-7.3)

		LSR	26.0 (14.5-50.7)	25.4 (20-40)	3.63 (1.8-6.79
		SSR	28.2 (20.8-32.70)	23.8 (20-26)	4.39 (2.7-5.9)
Raha	Monomorphic	Hybrid	21.2 (9.5-35.5)	36.4 (34-389	5.34 (2.2-11.2)
		LSR	18.4 (6.4-39.5)	30.0 (24-35)	3.53 (1.1-7.8)
Ropi	Polymorphic	DR	16.1 (6.5-29.3)	33.8 (22-39)	4.81 (2.6-6.5)
		LSR	20.3 (12-31.4)	26.9 (22-34)	3.11 (2.1-4.5)
Sarki	Monomorphic	Hybrid	19.2 (13.5-25.7)	39.4 (33-44)	5.20 (3.3-7.1)
		LSR	19.6 (6.8-29.2)	32.9 (26-40)	3.87 (1.2-5.9)
Sarkilompolo	Monomorphic	Hybrid	14.1 (11.6-25)	41.3 (36-47)	4.46 (3.4-7.3)
		LSR	21.5 (11.5-43.4)	30.4 (19-51)	3.40 (1.7-6.0)
Siilas	Monomorphic	LSR	26.3 (14.8-43)	24.7 (20-30)	4.34 (2.5-8.4)
Toras	Monomorphic	LSR	18.9 (9.5-32.3)	23.8 (17-38)	2.59 (1.5-5.9)
Tsahkal	Monomorphic	LSR	22.2 (11.5-46.2)	28.3 (21-37)	3.82 (1.8-6.6)
		DR	16.4 (13.3-20.2)	33.8 (30-39)	4.45 (3.3-5.6)
Ukko	Polymorphic	LDR	30.0 (20.1-37.8)	31.7 (24-36)	5.6 (3.5-7.5)
		LSR	24.7 (12.4-43.6)	24.1 (19-34)	3.35 (1.4-6.2)
Vaggoval	Monomorphic	LSR	22.5 (8.2-35.7)	26.7 (23-31)	3.59 (1.1-6.3)
Vastus	Polymorphic	DR	8.7 (6.7-16.4)	33.3 (22-38)	2.10 (1.4-3.7)
		LSR	20.5 (7.2-35.8)	23.5 (19-34)	2.67 (1.1-4.7)
Vuontis	Monomorphic	LSR	17.4 (7-43.9)	28.2 (21-34)	3.25 (2.4-4.4)

Appendix 4. List of invertebrate taxa present in the environment (pelagic, littoral and profundal) and stomachs.

Table 4A. List of taxa present in the stomachs and in the environment. L=larva, N=nymph and P=Pupae. Present (+) and absent (-).

	Code name	Pelagic	Littoral	Profundal	Stomachs
Aquatic invertebrates					
Alona spp.	Alo	+	-	-	+
Bosmina spp.	Bos	+	-	-	+
Bythotrephes spp.	Byt	+	-	-	+
Calanoida	Cal	+	-	-	+
Chydorus spp.	Chy	+	-	-	+
Cyclopoida	Cyc	+	-	-	+
Megacyclops spp.	Meg	-	+	+	+
Daphnia spp.	Dap	+	+	-	+
Holopedium spp.	Hol	+	-	-	+
Leptodora spp.	Lep	+	-	-	+
Polyphemus spp.	Pol	+	+	-	+
Eurycercus spp.	Eur	-	+	+	+
Mysis spp.	Mys	-	+	+	+
Ostracoda	Ost	-	+	+	+
Gordius spp.	Gor	-	+	+	+
Nematoda	Nem	-	+	+	-
Oligochaeta	Oli	-	+	+	-
Hirudinea	Hir	-	+	+	+
Turbellaria	Tur	-	+	+	-
Hydracarina	Hyd	-	+	+	+
Gammarus spp.	Gam	-	+	+	+
Asellus spp.	Ase	-	+	+	+
Pisidium spp.	Pis	-	+	+	+
Lymnaea spp.	Lym	-	+	+	+
Valvata spp.	Val	-	+	+	+
Ceratopogonidae (L)	Cer	-	+	+	+
Chironomidae (L)	Chi	-	+	+	+
Chironomidae (P)	Chi	-	-	-	+
Simuliidae (L)	Sim	-	-	-	+
Tabanidae (L)	Tab	-	+	+	+
Tipulidae (L)	Tip	-	+	-	+
Corixidae	Cor	-	+	-	+
Dytiscidae (L)	Dyt	-	+	+	+
Plecoptera (L)	Ple	-	+	+	+
Sialis spp. (L)	Sia	-	+	+	+
Trichoptera (L)	Tri	-	+	+	+
Trichoptera (P)	Tri	-	-	-	+
Ephemeroptera (N)	Eph	-	+	+	+
Ephemeroptera (P)	Eph	-	-	-	+
Odonata (N)	Odo	-	-	-	+
Surface prey					
Terrestrial insects	-	-	-	-	+
Emerged aquatic insects	-	-	-	-	+
Geometric moths	-	-	-	-	+
Spider	-	-	-	-	+
Ant	-	-	-	-	+

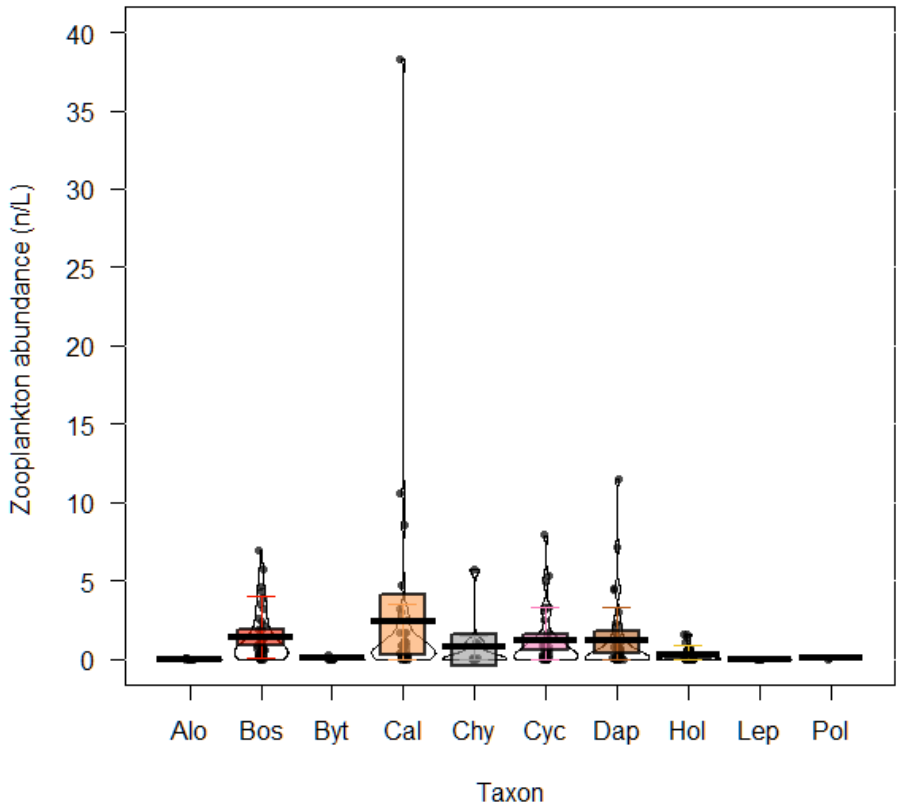

Figure 4A. Relative abundance of zooplankton in the pelagic habitat. For the abbreviations please see Table 4A.

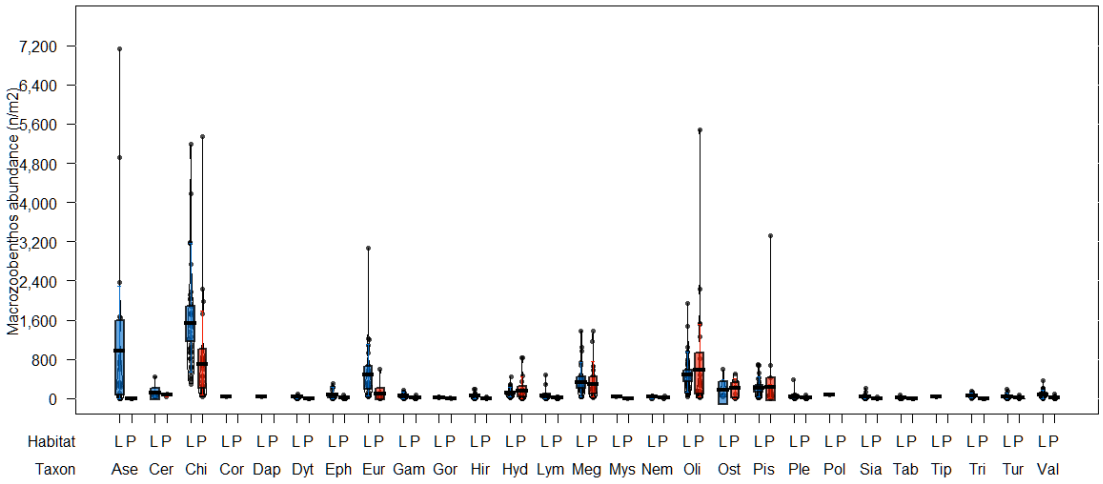

Figure 4B. Relative abundance of macrozoobenthos in the littoral (L) and profundal (P) habitats. For the abbreviations please see Table 4A.

Appendix 5. Correlation (Pearson's) table showing the relationship between individual and populational feeding (individual trophic specialisation and Levins' index, respectively) and potential predictors (environmental status, ecological opportunity, total CPUE, species-specific CPUE, fish richness and predation risk). Note predation risk was calculated as invertivorous CPUE/piscivorous fish CPUE ratio.

Table 5A. Correlation table showing the relationship between individual trophic specialisation and potential predictors. Statistically significant associations are marked in bold.

	Perch		Ruffe		Vendace		LSR whitefish	
	r	*p*	*r*	*p*	*r*	*p*	*r*	*p*
Environmental status								
Climate-productivity index (CP_i)	**0.47**	**0.033**	0.08	0.752	-0.34	0.271	**-0.49**	**0.006**
Lake morphometry index (M_i)	**0.45**	**0.037**	-0.19	0.338	-0.02	0.947	-0.16	0.407
Zooplankton								
Bosmina spp. (n L^{-1})	0.29	0.193	0.04	0.876	**-0.66**	**0.019**	**-0.39**	**0.038**
Calanoida (n L^{-1})	-0.03	0.899	0.35	0.184	-0.27	0.390	0.24	0.209
Chydorus spp. (n L^{-1})	0.34	0.129	-0.05	0.860	0.01	0.994	-0.18	0.347
Cyclopoida (n L^{-1})	**0.44**	**0.047**	-0.28	0.289	-0.21	0.515	-0.26	0.180
Daphnia spp. (n L^{-1})	0.36	0.112	0.14	0.588	**-0.70**	**0.010**	**-0.53**	**0.003**
Total density (n L^{-1})	**0.45**	**0.039**	0.04	0.865	**-0.65**	**0.021**	-0.28	0.143
Taxa richness	0.23	0.319	0.04	0.868	-0.13	0.678	**-0.44**	**0.015**
Macrozoobenthos (littoral)								
Asellus spp. (n m^2)	0.10	0.658	0.01	0.979	0.16	0.605	-0.08	0.677
Chironomidae (n m^2)	0.35	0.116	-0.08	0.769	-0.21	0.509	-0.28	0.142
Eurycercus spp. (n m^2)	0.33	0.145	-0.33	0.217	0.01	0.998	**-0.50**	**0.005**
Total density (n m^2)	0.29	0.195	-0.16	0.550	0.19	0.555	-0.32	0.091
Taxa richness	-0.25	0.271	0.09	0.729	0.44	0.146	-0.04	0.835
Macrozoobenthos (profundal)								
Chironomidae (n m^2)	0.13	0.581	**-0.59**	**0.017**	0.24	0.482	-0.11	0.582
Pisidium spp. (n m^2)	0.08	0.732	-0.50	0.050	0.13	0.709	-0.11	0.550
Total density (n m^2)	0.10	0.651	**-0.57**	**0.020**	0.34	0.303	-0.21	0.269
Taxa richness	-0.08	0.730	-0.31	0.248	0.38	0.251	-0.06	0.759
Fish community								
Total CPUE	**0.58**	**0.005**	0.14	0.590	-0.33	0.286	**-0.55**	**0.002**
Species-specific CPUE	0.35	0.123	0.11	0.695	0.35	0.259	0.04	0.812
Predation risk	0.23	0.324	-0.16	0.537	-0.49	0.107	**-0.37**	**0.049**
Taxa richness	-0.28	0.212	**0.56**	**0.025**	-0.11	0.724	-0.14	0.478

Table 5B. Correlation table showing the relationship between population niche breadth (Levins' index) and potential predictors. Statistically significant associations are marked in bold.

	Perch		Ruffe		Vendace		LSR whitefish	
	r	*p*	*r*	*p*	*r*	*p*	*r*	*p*
Feeding								
Individual trophic specialisation	**0.88**	**<0.001**	**0.92**	**<0.001**	**0.85**	**<0.001**	**0.89**	**<0.001**
Environmental status								
Climate-productivity index (CP_i)	0.39	0.080	-0.08	0.749	-0.40	0.202	-0.32	0.090
Lake morphometry index (M_i)	0.41	0.061	-0.01	0.976	-0.06	0.847	-0.04	0.829
Zooplankton								
Bosmina spp. (n L^{-1})	0.31	0.167	-0.08	0.766	-0.52	0.080	-0.30	0.109
Calanoida (n L^{-1})	-0.08	0.736	0.18	0.514	-0.13	0.683	0.10	0.59
Chydorus spp. (n L^{-1})	0.26	0.252	-0.04	0.877	-0.03	0.923	-0.10	0.594
Cyclopoida (n L^{-1})	**0.54**	**0.011**	-0.18	0.492	-0.16	0.623	-0.19	0.319
Daphnia spp. (n L^{-1})	0.30	0.178	0.01	0.956	-0.48	0.115	**-0.40**	**0.030**
Total density (n L^{-1})	**0.44**	**0.047**	-0.04	0.865	-0.48	0.115	-0.25	0.196
Taxa richness	0.13	0.568	-0.15	0.583	-0.35	0.259	**-0.40**	**0.030**
Macrozoobenthos (littoral)								
Asellus spp. (n m^2)	-0.07	0.772	-0.01	0.984	-0.14	0.668	-0.09	0.614
Chironomidae (n m^2)	0.29	0.193	-0.22	0.413	-0.26	0.414	-0.23	0.222
Eurycercus spp. (n m^2)	0.42	0.057	-0.16	0.543	0.01	0.989	-0.31	0.101
Total density (n m^2)	0.16	0.487	-0.15	0.567	-0.11	0.727	-0.23	0.233
Taxa richness	-0.38	0.089	0.10	0.710	0.28	0.388	-0.12	0.534
Macrozoobenthos (profundal)								
Chironomidae (n m^2)	0.01	0.994	**-0.59**	**0.016**	-0.07	0.833	-0.06	0.733
Pisidium spp. (n m^2)	0.11	0.641	**-0.51**	**0.042**	0.08	0.804	0.02	0.917
Total density (n m^2)	0.11	0.646	**-0.53**	**0.032**	0.18	0.563	0.01	0.986
Taxa richness	-0.07	0.762	-0.13	0.623	0.138	0.668	-0.01	0.966
Fish community								
Total CPUE	**0.59**	**0.005**	0.01	0.966	-0.29	0.365	**-0.44**	**0.017**
Species-specific CPUE	0.30	0.190	0.08	0.763	0.03	0.917	-0.06	0.738
Predation risk	0.13	0.585	-0.21	0.439	-0.45	0.143	-0.34	0.071
Taxa richness	-0.22	0.327	0.47	0.066	-0.02	0.941	-0.26	0.178

Appendix 6. Residual plot of the best models explaining the variation in feeding of fish species.

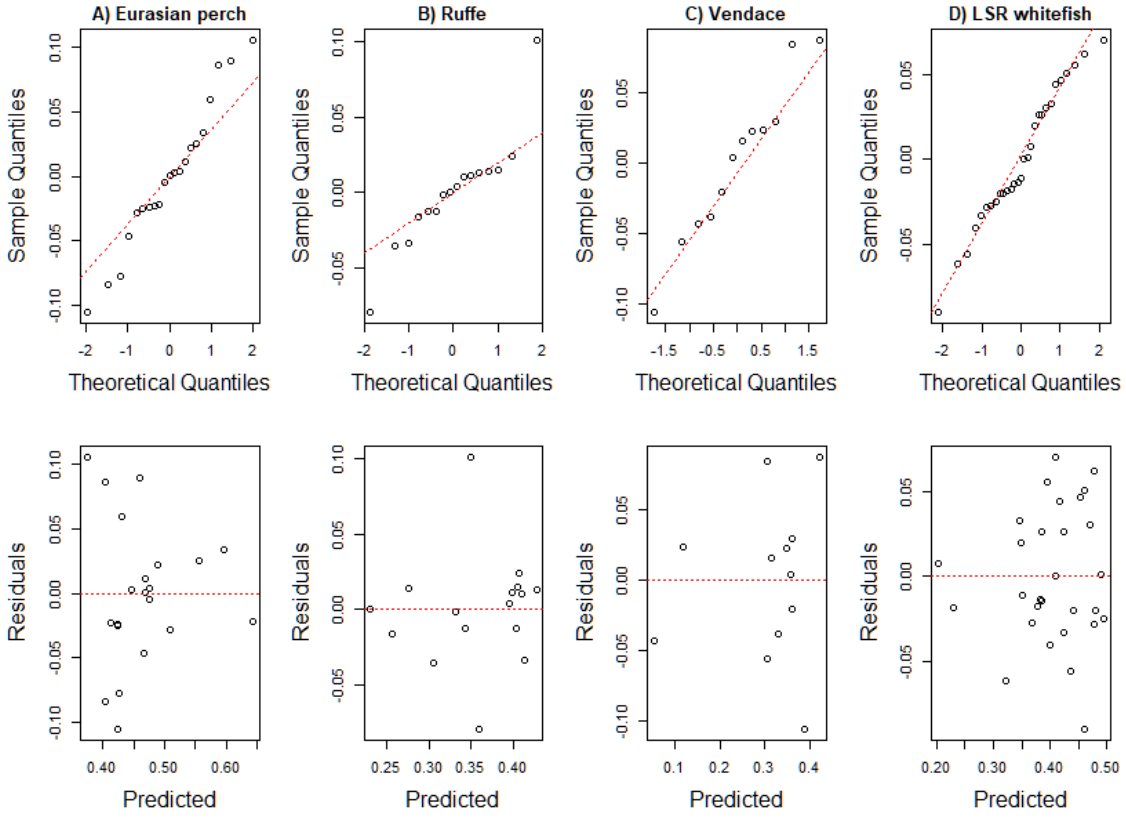

Figure 6A. Residual plot of the best models explaining the variation in individual trophic specialisation. Q-Q plot in the upper row and Homogeneity in the bottom row.

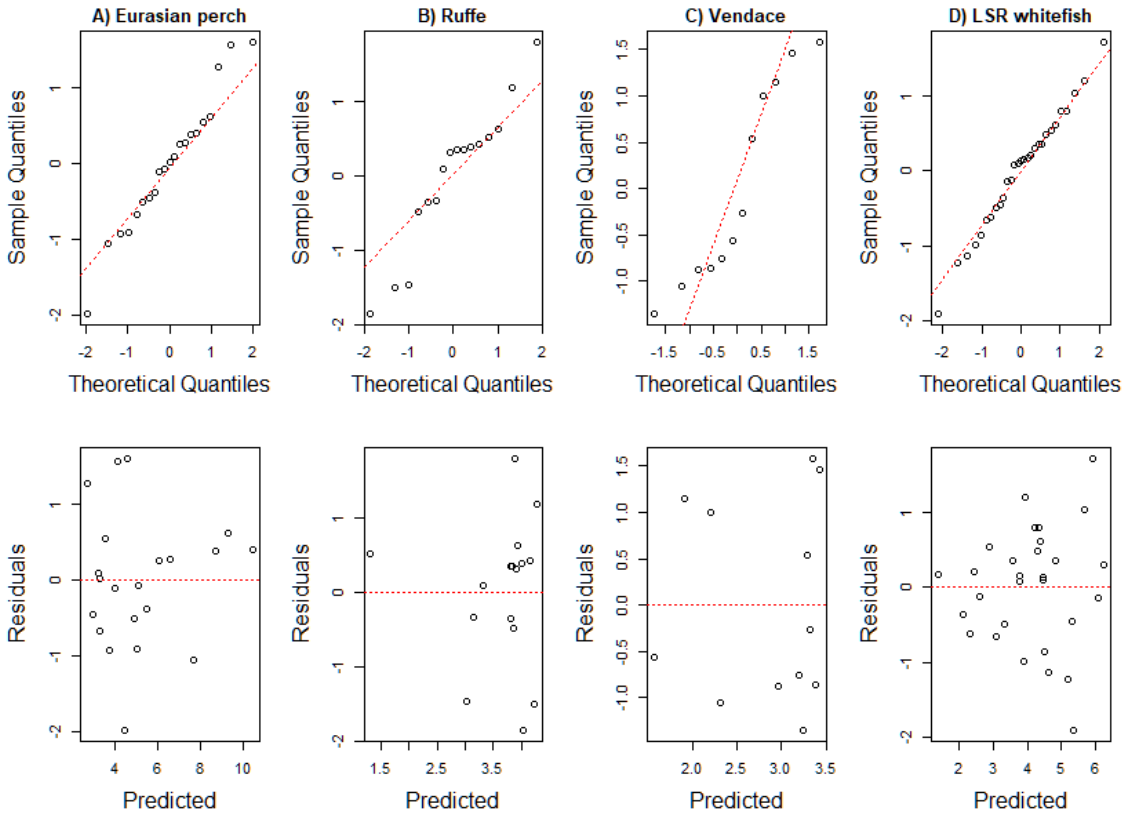

Figure 6B. Residual plot of the best models explaining the variation in population niche breadth (Levins' index). Q-Q plot in the upper row and Homogeneity in the bottom row.

Appendix 7. Patterns in resource availability (zooplankton and littoral macroinvertebrates densities, in blue) and fish abundance (in red) along climate-productivity gradients (CP_i). Linear smoothers (shaded area denotes 95% confidence interval) are fitted to the data for illustrative purposes of the patterns to show trends.